The Integrator

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A Message from the Associate Director of the Mission Services Program

I would like to take this opportunity to personally welcome all of the staff who have come together to form the Mission Services Program. Effective August 1, 1999, Code 450 was officially reorganized to integrate the Tracking and Data Relay Satellite (TDRS), Orbital Launch Services (OLS), Rapid Spacecraft Development Office (RSDO), the Integrated Financial Management (IFM), Space Network, Ground Network, and Mission and Data Systems Projects within one Program Office. None of these projects is new to Goddard. In fact, they have each been a successful part of the Flight Projects Directorate for some time. The decision to include these projects in the Code 450 organization was made to bring service organizations in parallel with the Code 400 program and project management structure. I am pleased with this decision, as I believe it has enhanced our ability to meet the expansive variety of needs our customers have.

We have been busy over the last few months. The IFM Project recently conducted a successful System Architecture Review, culminating with the documentation of the basic architecture. Our staff has also been busy providing support for numerous launches on the horizon, including TERRA, the Shuttle support for the next Hubble Servicing Mission, GOES, and TDRS-H. With the TDRS Project now an integral part of our team, the TDRS-H deployment will be even more exciting! The Rapid II Spacecraft Procurement offering, expected in January 2000, will consist of a new set of tools to help ensure our customers' success. Other areas of focus include the Ka-Band Initiative and collaboration with the Jet Propulsion Laboratory on the Mars Project. Also of significance is the progress we have made working through the challenges brought about by the Consolidated Space Operations Contract (CSOC) transition, commercialization of services, and decreased budgets.

Time and again, we have displayed our winning combination of customer focus, expertise, and dedication to achieving excellence. We have much to look forward to in the coming months. I look to our future with excitement and confidence that we will continue to play a valuable, mission-enabling role for NASA in the year 2000 and beyond.

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Highlights in This Issue...

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Mission Services Program Elements

Mission Services Program Office Welcomes Staff

The Mission Services Program Office (MSPO), GSFC Code 450, reorganized recently. In the past, the focus of *The Integrator* has been on space and ground networks and mission and data systems. With the reorganization, our scope will broaden to include activities related to the Tracking and Data Relay Satellite (TDRS) Project, Code 454 (formerly Code 450); the Integrated Financial Management Project (IFMP), Code 455 (formerly Code 401.2); the Rapid Spacecraft Development Office (RSDO), Code 456 (formerly Code 401.5); and the Orbital Launch Services (OLS) Project, Code 457 (formerly Code 470).

The Mission Services Program has some unique characteristics—it is comprised of multiple projects which are required for the success of flight projects. Our projects serve multiple enterprises, both internal and external to NASA. Despite its unique aspects, the MSP is an integral part of the Code 400 organization. This reorganization provides the centralized functions customers require when they seek solutions to their mission services needs. Our organization is in a much better position to understand and provide solutions for our customers' full life-cycle needs—from procurement of spacecraft and consultation for launch services, to acquisition of a variety of tracking and data communications systems, to comprehensive flight mission operations, to consistent business management of services provided.

The TDRS Project's mission is to manage the design, construction, test, and launch of satellites which form the space-based portion of NASA's Space Network. OLS supports the acquisition and management of small- and medium-class expendable launch vehicle-based commercial launch services for use in the delivery of NASA or NASA-sponsored primary and secondary scientific payloads into orbit. The RSDO is responsible for the management and direction of a dynamic and versatile program directing the definition, competition, and acquisition of multiple Indefinite Delivery Indefinite Quantity (IDIQ) contracts, to offer NASA and other United States Government Agencies extremely fast procurement of spacecraft for future missions. These small to medium sized missions are characterized by relatively low to moderate cost, and are capable of being built, tested and launched in a short time. The IFMP provides technical leadership and direction for the acquisition, implementation, and sustaining engineering of a standardized, Agency-wide business system.

Highlights of these Project's responsibilities are described in the following articles.

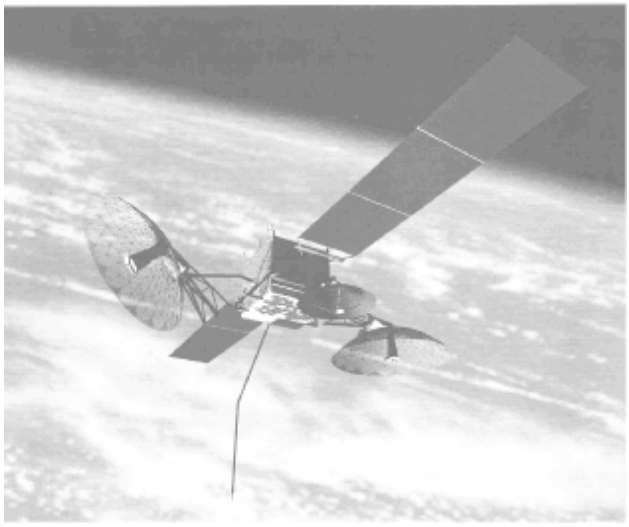
An Organizational Chart of the Mission Services Program

Tracking and Data Relay Satellite Project Readies New Fleet

Since the first Tracking and Data Relay Satellite (TDRS) was launched in April 1983, NASA's TDRS satellites have been providing NASA astronauts with a voice and data link to the Earth as well as relaying data to and from numerous unmanned scientific satellites. Five of the six TDRS spacecraft currently in orbit were designed in the 1970s; the remaining one included some 1990 upgrades.

Anticipating expanded communication requirements for current and future missions, NASA is acting to maintain the fleet and expand its capabilities. TDRS H, I, J are being built by Hughes Space and Communications Company in El Segundo, California. The trio will extend NASA's tracking and communication services for another 15 years. TDRS H is expected to launch

the first quarter of 2000 aboard an Atlas IIA expendable launch vehicle.



TDRS H, I, J Spacecraft
(Courtesy of Hughes Space and Communications)

At liftoff, the spacecraft will weigh approximately 7000 pounds. The spacecraft dry weight is projected to be 3371 pounds; the remainder will be propellant. The spacecraft has six deployable appendages: two solar array wings, two large single access antennas, a space-to-ground link antenna and an omni antenna. The two solar array wings each consist of three folded panels. When deployed, the satellite measures nearly 68 feet (21 meters) from the tip of one solar wing to the other – about the height of a 7-story building.

The TDRS H, I, J provide 18 service interfaces to customer spacecraft. The on-board communications payload can be characterized as bent-pipe repeaters, in that no baseband signal processing is done by the TDRS.

S-band Multiple Access – The phased array antennas are designed to receive signals from five spacecraft at once, while transmitting to one, providing simultaneous service to satellites that generate time-critical data. Improvements in the multiple access gain-to-noise temperature ratio and on-board processing have contributed to increasing the data rate to 30 times that of the existing fleet. The forward service transmitting power is increased by eight decibels. These improvements permit the off-loading of many satellite customers from the current fleet's busy S-band Single Access antennas to the TDRS H, I, J Multiple Access system.

S-band Single Access – Two 15-foot diameter mechanically steerable antennas offer a range of frequencies, providing high gain support to satellites with low-gain antennas or Multiple Access customer satellites temporarily requiring an increased data rate. They are used to support manned missions, science data missions, including the Hubble Space Telescope and satellite data dumps.

Ku-band Single Access – The two large antennas also operate at a higher bandwidth supporting high-resolution digital television including all space shuttle video communications. Recorders aboard NASA satellites will be able to dump large volumes of data at rates of up to 300 million bits per second. That is equivalent to a 20-volume set of encyclopedias, totaling approximately 6 million words per second.

Ka-band Single Access – A new tunable, wideband, high frequency service offered by the two large antennas provides the capability of transmitting up to 800 million bits of information per second, anticipated for use by future missions. The new Ka-band frequencies also establish international compatibility with Japanese and European space relay programs allowing for mutual support in case of emergencies.

TDRS H, I, J use an innovative spring-back antenna design pioneered by Hughes. The 15-foot diameter pair of flexible graphite-mesh antenna reflectors is furled into a taco shape for launch. On orbit, the antennas spring open into their original parabolic shape. The springback antennas are equipped with a mechanism to allow for on-orbit contour adjustments.

The TDRS H, I, J contractor is responsible for making the necessary changes to the existing White Sands Complex (WSC) that operates the TDRS spacecraft. The prime spacecraft contractor through its subcontractor, Raytheon

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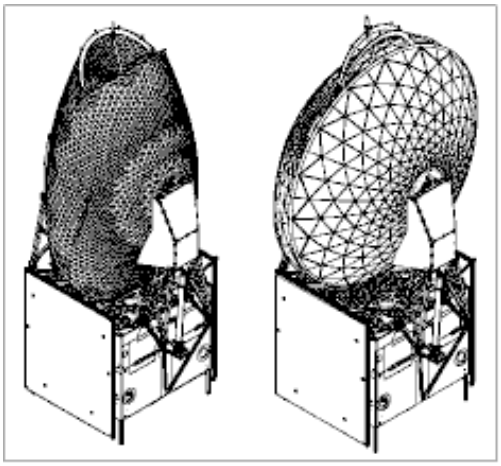

(Left) TDRS H, I, J spacecraft in the stowed/launch configuration with the single access antenna reflectors folded into a "taco" shape.

(Right) TDRS H, I, J spacecraft in the transfer-orbit configuration with reflectors unfurled.

(continued from page 5)

Systems Corporation in Denver, developed the WSC ground segment changes necessary for spacecraft compatibility with TDRS H, I, J while maintaining backward compatibility with existing TDRS (F1-F7) spacecraft. The ground modifications are completed and have been provisionally accepted. Staff training is currently underway.

Awaiting resolution of the investigation into the recent launch vehicle failure, the spacecraft underwent additional confidence testing this fall. Final Integration Systems Test and Hughes Mission Control Center/WSC compatibility testing is taking place in mid/late November. Launch is expected to take place in the first quarter of 2000.

By Sheila M. Stanford, Project Support Specialist, Code 454.

For additional information, please contact the author at (301) 286-8617

Integrated Financial Management Project

GSFC's Integrated Financial Management Project (IFMP) Technical and Contract Office (Code 455) is responsible for managing the contract to implement an Integrated Financial Management (IFM) System throughout NASA, providing technical leadership to the IFMP effort during implementation and sustaining support of the IFM system, managing the IFMP budget, and participating in overall project planning. The Code 455 project manager, Bobby German, works directly with NASA HQ Code B in the overall management of IFMP.

The Chief Financial Officer established the IFMP to plan, coordinate, and manage all aspects of the work necessary to acquire and implement a single, integrated financial management system throughout NASA. The principal goal of the IFMP is to improve financial management processes throughout the agency. To accomplish this goal, the IFMP has developed the following objectives:

- Standardize financial management business processes that are compliant with the Federal Government's Joint Financial Management Improvement Program (JFMIP).
- Provide current, meaningful, and timely financial information for both internal and external customers.
- Acquire an integrated, standardized, computer-based system to support financial management processes.

The IFMP strategy includes an Agency-wide Business Process Reengineering (BPR) effort; the implementation of full cost budgeting, accounting, and management practices; the acquisition of Commercial Off-the-Shelf (COTS) software; and the inclusion of the Centers in key planning and implementation aspects of the project. All Centers have formed teams with functional and technical expertise to plan and support the implementations at their respective locations. The financial management processes that the IFM System will initially focus on include:

- *Core Financial:* budget execution, recording and controlling funds, recording cost (including full cost accounting and labor distribution), disbursing and advancing funds, billing and collecting accounts receivables, Standard General Ledger, financial classification structure, and reporting.
- *Budget Formulation:* integrated budget planning linked to strategic plans, standardized data, schedule, formats, and guidance for budget calls and submittals and recording, maintaining, and reporting budget data for many multibudget cycles.
- *Time and Attendance:* exception-based reporting, shifting of responsibility for maintaining electronic time sheets to individual employees, simplifying an attendance certification process, and using electronic routing and approval.
- *Procurement:* an end-to-end procurement process that is integrated with other business systems, reduced number of approvals, expansion of credit-card purchasing, and automated closeout for simplified acquisitions processed outside the Procurement Office.
- *Travel:* initiation of travel requests by the traveler, reduced number of approvals, use of flat rate per diem, random statistical sampling of travel vouchers, and end-to-end electronic processing of travel data from the initiation of the travel request through the payment of the travel voucher.
- *Executive Information System (EIS):* allows NASA enterprise, project and functional managers to obtain more accurate and timely status and decision-making information.

The initial phase of the IFM System implementation begins in Fiscal Year 2000. Asset Management, Grants Management, and Human Resources-Payroll Management will be implemented at later dates.

By Bobby German/GSFC Code 455

For additional information, please contact the author at (301) 286-6248 or via email at bgerman@ifmp.gsfc.nasa.gov

The Rapid Spacecraft Development Office Is Changing the Way NASA Works

In the late 1980s, the number of unmanned space missions launched by commercial entities each year began to exceed those executed by NASA. This shift in roles, fueled by the shrinking portion of the Federal budget allocated to NASA, prompted NASA leaders to develop creative strategies designed to maintain, and even enhance, NASA's role as the nation's space technology leader. Many of these strategies involve changes in the culture and business methods of the organization. NASA leaders decided to borrow from the successes of private industry, making use of commercial best practices and products. To reduce redundancy, outsourcing is to be accomplished whenever possible, and the customer (whether internal or external) is to be the focus for work performed. This change in philosophy allows civil servants to concentrate more on development of future technology needs and to even "seed" those technologies within industry. These strategies were rolled out to all employees in the NASA Strategic Plan in 1998.

In response to the Agency's plan, GSFC formed the Goddard 2005 team to identify methods to enable the transformation at GSFC. The Goddard 2005 team identified several goals for the Center, including reducing the time required for satellite acquisitions and delivery and increasing the use of commercial products and the total number of missions flown per year.

In 1997 GSFC established the Rapid Spacecraft Development Office (RSDO) to bring about many of the aforementioned advancements. The RSDO specializes in formulating innovative teaming arrangements between the Government and private industry, allowing fast, cost-effective spacecraft procurement. Since its inception, the RSDO has instituted several initiatives designed to meet the challenges posed to GSFC.

One of these initiatives, the Rapid Spacecraft Acquisition (RSA), is designed to reduce the acquisition and delivery time required for standard satellite busses. RDSO personnel researched both industry capabilities and Government needs to find a suite of commercial satellite busses that could be easily utilized for future NASA missions. RSDO then set up an Indefinite Delivery Indefinite Quantity (IDIQ) contract with multiple awards to establish a catalog of 16 available busses from 8 vendors. Customers can now hold "mini-competitions" among vendors from the catalog, choose a winner, and place an order. To further increase the customer base, NASA is allowing any U.S. agency to utilize RSA. To encourage organizations to participate, NASA allows transfer of the contract and technical responsibility to the customer after the award is made, thereby enabling customers to retain control of the vendor during the build phase. Typical RSA "mini-competitions" take 30-90 days and savings are estimated to be $20-30 M per mission. QuikSCAT (see article page 21), ICESAT, QuikTOMS, and the USAF's Coriolis mission all took advantage of the RSA opportunity. Investigators are also utilizing RSDO services to partner with industry in the Explorer and Earth Science Announcement of Opportunity competition.

RSDO's Quick Ride program is another time and cost savings option available to qualifying missions. This program takes advantage of secondary payload space that is frequently available on commercial satellite vehicles. RSDO matches up potential science missions with commercial space ventures that have secondary space available. Qualifying Quick Ride science payloads must be compatible with existing commercial mission requirements for mass, power, orbit, and launch date and must not pose a risk to the primary mission. To enable such Government/commercial partnerships, the RSDO set up an IDIQ contract similar to the RSA initiative, along with a catalog of available primary commercial missions. It is anticipated that missions utilizing the Quick Ride program will cost only about $3M, a significant savings over the typical $18M it would cost to launch by conventional means. The Quick Ride contract also contains an interesting new feature known as an on-ramp. The on-ramp capability allows vendors to offer additional missions and new companies to be added to the catalog after the inception of the contract. Although Quick Ride ventures are high risk because of the nature of the emerging commercial sector, they also offer potential high return from a low investment.

Currently, we at RSDO are preparing the follow-on to the RSA, the Rapid II contract, which will commence in January 2000. We are also investigating technology transfer opportunities that may benefit either NASA or its contracting partners, the vendors. We believe that innovations such as those instituted by the RSDO will enable NASA to increase the effectiveness and speed of its spacecraft development processes.

For additional information, please visit the RSDO home page at http://rsdo.gsfc.nasa.gov/ or contact Scott Greatorex/Acting Chief, Rapid Spacecraft Development Office at (301) 286-6354.

Goddard's Orbital Launch Services Project Moves to KSC

Goddard is bidding a fond farewell to one project that has been in existence for 40 years. Effective October 1, 1998, Goddard's Orbital Launch Services (OLS) Project transferred much of its responsibility to Kennedy Space Center (KSC), FL. Some project personnel remain behind at Goddard to provide expertise and assistance to KSC during the project's transition period, through September 2000.

The OLS Project's mission evolved from its early days of procuring expendable launch vehicles to procuring high-quality and reliable small- and medium-class expendable launch services. Goddard's OLS Project successfully managed diversified launch services under five separate Expendable Launch Vehicle (ELV) service contracts:

- Medium Expendable Launch Vehicle Services (MELVS)
- Medium-Lite Expendable Launch Vehicles Services (MED-LITE)
- Small Expendable Launch Vehicle Services (SELVS)
- Ultra-Lite Expandable Launch Vehicle Services (UELVS)
- And a Memorandum of Agreement with the U.S. Air Force for the TITAN-II Space Launch Vehicle (SLV).

According to Bruce Clark, OLS project manager, all services have successfully transferred to KSC."The Center should be very proud of the accomplishments made by both Delta and OLS project personnel over the past five decades. We have accomplished everything we set out to do and did it well," Clark said.

The Delta Project, as it was originally named, was established at Goddard during a period when the United States Space Program was in need of reliable launch vehicles. The Delta rocket was meant to be an "interim space launch vehicle" made up of existing systems which would keep the launch program active until new vehicles could be developed and successfully flown. NASA awarded the $24 million contract to the Douglas Aircraft Co. (now the Boeing Co.) for the development, integration and production of 12 medium-class launch vehicles.

Although the initial launch on May 13, 1960 was unsuccessful, the remaining 11 Delta launch vehicles procured under the first contract were launched without a hitch. A follow-on contract provided for 14 more launch vehicles of greater performance capability. The rest, as they say, is history.

The early days of the Delta Project were managed by a young, pioneering engineer whose aggressive marketing of Delta upgrades led to the first truly commercial launch vehicle hardware venture known as the RCA/McDonnell Douglas 3914 Program. Bill Schindler's extraordinary management practices during his 12-year career as project manager earned him the title of "Mr. Delta" along with NASA's highest honor, the Distinguished Service Award.

"He was the Delta program," remarked John Langmead, former OLS Deputy Project Manager for Resources. "Without Bill, there wouldn't have been a Delta Project." Langmead, who was assigned to the OLS Project from 1988 to 1998, said the best part about working there was the people—their creativity and motivation were unending.

Over the years, Goddard's Delta project successfully launched several pioneering satellites into space—

- TIROS II, launched on a Delta rocket in 1960, which became the first satellite to be used operationally for daily weather forecasting.
- RELAY I, launched in 1962, became the first communications satellite to link three continents for "live" television.
- INTELSAT I, launched in 1965, became the first commercial communications satellite.
- LANDSAT I, launched in 1972, became the first satellite to provide daily monitoring of the Earth's limited, natural resources.
- COBE, launched in 1989, validated the cosmic background radiation predicted by the Big Bang theory of the birth of the Universe.

In 1989, the Delta Project changed its name to the Orbital Launch Services (OLS) Project. Between 1989 and 1995, the OLS project began procuring a variety of expendable launch vehicle services under the SELVS, MELVS, MED-LITE, and UELVS contracts. In addition, OLS managed the last five Scout launches and the Atlas-E/F and Titan-II SLV launches through the US Air Force. Working always as an integrated team, OLS project personnel took the commercial launch services concept and evolved it into the sleek, well-run program that it is today.

"We took the concept of launch services and turned it into something that is pretty much taken for granted today," Langmead said. Unlike some Government/private industry programs, the relationship between NASA and its contractors was based on a high degree of mutual respect and admiration. "Everyone worked together in a cooperative atmosphere for the betterment of the project," Langmead said.

A Goddard plaque created for project employees sums up the past 40 years appropriately with its title, "A Proud Legacy: 1959-1998."

Excerpted from an article by Susan Hendrix/GSFC Office of Public Affairs

Science Data Processing Facility Improves Service for SAMPEX

The Science Data Processing Facility (SDPF) has transitioned to a new system for providing level-zero processing and distribution services to the Solar, Anomalous, and Magnetospheric Particle Explorer (SAMPEX) Project. On September 22, SDPF support of SAMPEX transitioned from the multi-mission Pacor II system to the single-mission SAMPEX Data Processing System (DPS) as part of the overall SAMPEX Ground Data System (GDS) Reengineering effort.

SDPF personnel were involved in the system testing, parallel testing, and transition to operations of the SAMPEX DPS, which is a data-driven system that provides increased automation for data receipt and processing. The DPS receives file transfers of spacecraft data from the ground stations post-pass. Therefore, SDPF personnel no longer are required to schedule the system for data receipt or initiate and monitor real-time data receipt contacts with the spacecraft. Also, since the file transfers are received and archived on the DPS, the Generic Block Recording System (GBRS) is no longer required for data archiving purposes.

The SAMPEX DPS generates level-zero data products for SAMPEX and delivers these products directly to the University of Maryland Science Operations Center (UMSOC), eliminating the need for the Data Distribution Facility (DDF) previously required.

The SDPF has supported SAMPEX using a variety of innovative solutions since its launch on July 3, 1992. Originally, SDPF provided level-zero processing and distribution services for SAMPEX using the Pacor I system. SAMPEX support was transitioned to the Pacor II and DDF facilities on October 1, 1997, to take advantage of the increased automation and improved reliability afforded by these systems. Support for SAMPEX remained on Pacor II and the DDF until this latest transition to the Sampex DPS.

By Brian Repp/ATSC

For further information, please contact the author via telephone at (301) 286-3699 or via email at Brian.D.Repp.1@gsfc.nasa.gov

User Planning System Release 12 Deployment Postponed Until After 2000

Although User Planning System (UPS) Release 12 (which supports the flexible scheduling features available with NCC 98) is available to customers, the NASA-wide Year 2000 (Y2K) software freeze has postponed deployment at any customer site until after the new year.

The impact to customers, although substantial, will not affect their ability to continue to conduct mission operations. Customers have indicated that although the use of flexible scheduling would simplify their Space Network scheduling tasks, they are willing to continue using the current system—Release 11, Version 4—until Release 12 becomes available after January 1, 2000.

The UPS would like to welcome a new customer—Gravity Probe-B. Gravity Probe-B will be connecting remotely to the Multi Satellite Operations Control Center (MSOCC) UPS from its mission planning center at Stanford University. Gravity Probe-B project personnel found it more cost effective to share the hardware/software/system administration/configuration management costs associated with the MSOCC UPS rather than purchase a stand-alone machine or develop their own interface to the Network Control Center. The addition of Gravity Probe-B brings the number of missions sharing the MSOCC UPS to seven: ERBS, EUVE, CGRO, TRMM, UARS, RXTE, and Gravity Probe-B.

By the time this article is published, development should be underway to enhance the UPS to support the TDRS H, I, J. The schedule calls for the UPS to be ready to support missions using TDRS H shortly after its launch.

Finally, as of this writing, all customers should have successfully transitioned to UPS Release 11, Version 4, and be communicating with the NCC via TCP/IP. As planned, support for the old UPS Nascom Gateway will be terminated. Customers can look forward to an era of more reliable communication via TCP/IP.

By Howard Michelsen /CSC / CSOC

Further information regarding the UPS Project can be found on the WWW at http://isolde.gsfc.nasa.gov/ups/ or contact the author via email at hmichels@cscmail.csc.com

White Sands Complex Engineers Implement New Enhancements

The efforts of the White Sands Complex (WSC) Engineering Section are the focus of this article. Both hardware and software personnel are hard at work on many new initiatives.

For example, the WSC Alternative Resource Terminal (WART) will provide NASA with a low cost, seventh Space to Ground Link Terminal (SGLT). The WART SGLT will be dedicated to the support of NASA's South Pole TDRSS Relay (SPTR). SPTR is currently supported via a full service SGLT.

WART is already being used to provide Tracking, Telemetry, and Command (TT&C) functions for TDRS 1 and is scheduled to be fully operational in December (see article on WART on page 26). WART uses the spare antenna at the Cacique Terminal and shares some equipment with Cacique's S-Band TT&C system. WART is not a full-feature SGLT (SPTR cannot utilize all of a TDRS's communications features) and will provide customer support via only one TDRS Single Access Antenna. The cost of WART to NASA, in both time and money, is several orders of magnitude less that the cost of building a new SGLT from scratch.

Another project, the Meteorological Instrumentation Sensor Technology (MIST), utilizes TDRS's Multiple Access Return (MAR) system to provide global support for the U.S. Navy's weather sensor system. MIST uses a dedicated beam former, which is installed in parallel with WSC's existing MA Beamforming Equipment (MABE). MIST operates on a non-interference basis with concurrent, normal MAR customer services.

Seismic-Star is a proposed commercial venture that will use the TDRSS to support oil exploration vessels around the globe. Seismic data will be relayed at rates of 300 to 600 Mbps via a TDRS K-Band, Single Access antenna support. Exploration vessels currently transport seismic information via magnetic tape, and the data transport times are several months. By utilizing the TDRSS, that time is reduced to less than one second—saving time and money.

The Ground Network (GN) Commanding project is an effort to expand TDRS command capabilities to include support options offered only by the GN. The capability of the TDRSS to provide GN Commanding has already been demonstrated by the WSC Engineering Staff in support of the FUSE satellite launch and early orbit checkout (see article on page 23). The addition of GN Command features will expand TDRSS support to satellites that depend on the declining number of ground stations.

The Danzante Site at WSC
(Photo courtesy of Bill Gardner)

The Third Generation Beamforming System (TGBFS) is similar to the MIST system (see TGBFS article on page 27). TDRS customers will be able to provide their own Beamformers, which will operate in parallel to WSC's existing MABE, in a manner similar to MIST. The customers will be required to provide their own receivers and data processing equipment, but will gain "On Demand Access" to the TDRS MA communications system. The TGBFS will expand WSC's current MA support limits by factors of ten, from five to 50 or more simultaneous MA customers per SGLT. The TGBFS customers will operate in a manner that is transparent to current MA supports.

The TDRS MA system uses a Phased Array Antenna which has a very large field of view and allows communications with numerous, simultaneous customer satellites. The number of available beamformers and receiver sets is the primary limit on the number of simultaneous TDRSS MA customer supports. Recent advances in technology have greatly reduced the cost and complexity of beamformers and have made the TGBFS project possible. The TGBFS project will reduce the costs associated with spacecraft supports and should benefit the scientific community worldwide.

The WSC Engineering Section's workload has been very demanding in recent months. The team's track record of providing successful support to projects of national importance is a testament to their exceptional skills, work ethic, and ingenuity.

By Douglas Perkins/ATSC/WSC Training

For more information, please see the WSC Project Office home page at http://wscproj.gsfc.nasa.gov or contact Jim Gavura, Station Director, or Bryan Gioannini, Deputy Station Director, at (505) 527-7000.

TCP/IP Services Supported at the White Sands Complex

The White Sands Complex TCP/IP Data Interface Service Capability (WDISC) is operational. WDISC allows Space Network (SN) customers to receive telemetry and send commands using TCP/IP. The WDISC system was officially delivered to Consolidated Space Operations Contract (CSOC) operations on May 1, 1999.

WDISC supported its first customer with the launch of the Far Ultraviolet Spectroscopic Explorer (FUSE) mission on June 24, 1999. WDISC successfully provided the early-orbit support expected and shortly after launch extended its support to provide higher-rate science data. The customer subsequently asked for and successfully received additional WDISC support during a critical science instrument turn-on phase. WDISC has provided FUSE support during 123 scheduled SN events, from launch through September 30. Christopher J. Silva, the FUSE Flight Team Manager, wrote:

"The SN White Sands Complex TCP/IP Data Interface Service Capability (WDISC) has proven to be invaluable to the FUSE mission. The extended views provided by the TDRSS allowed the FUSE mission to plan and conduct an extremely efficient launch and early orbit operation. The addition of the GN 16 khz command capability has also allowed the FUSE program to effectively handle major satellite contingencies as well as provide backup health and status monitoring support during periods when the FUSE primary ground station has been nonoperational."

WDISC is currently testing with New Millennium Program/ Earth Orbiter-1 (NMP/EO-1), which is scheduled to launch in December 1999. Future customers will include Gravity Probe-B (GP-B), Microwave Anisotropy Probe (MAP), Thermosphere Ionosphere Mesosphere Energetics Dynamics (TIMED), and Ultra-Long Duration Balloon Project (ULDBP).

By John Groom/ATSC

For additional information on WDISC, please contact the author via email at John.R.Groom.1@gsfc.nasa.gov or via telephone at (301) 286-7799.

Network Control Center News

The Network Control Center (NCC) has several ongoing activities and significant accomplishments to report for this issue of *The Integrator*. We mentioned in the last issue that, as a result of the NCC 98 delivery, several systems were being removed from the NCC since they were no longer needed. This system removal and elimination of excess of equipment is now complete. In addition, the equipment move from Building 12 and from the Greentech II Software Development Facility (SDF) into the NCC is also now complete.

Work is underway to install three PCs in the Forecast Scheduling area and in the Operations Control Room (OCR) to satisfy the scheduling and real-time monitoring requirements for the White Sands Complex (WSC) Alternative Resource Terminal (WART). The NCC will input schedules for WART and will monitor the WART Monitor and Control System (MCS) from the installed PCs. The NCC PCs will be connected to the WART via the Internet. The current schedule calls for TDRS-1 to be handed over to WART in November.

A fail over to the Auxiliary Network Control Center (ANCC) is being planned and coordinated and will take place in the near future. This will be the first time that a complete fail over to the ANCC cluster/servers will be exercised. To date, NCC Operations has transitioned to the ANCC workstations on several occasions while remaining on the operational server cluster.

NCC Operations is preparing for the upcoming HST servicing mission currently scheduled for December 2, 1999 (see HST article on page 12). NCC Operations has provided training to HST personnel [who will be using the Mission Management Area (MMA) during the mission] on the use of the Electrospace Systems Incorporated (ESI) communications panels and the video displays. Procedures detailing HST personnel NCC Access and Security are also being developed.

NCC Operations successfully transitioned to the new software baseline Service Planning Segment Replacement 99.1 (NCC 98 Completion Release) on June 21. NCC 99.1 Patch "H" was also delivered on August 18. This Patch fixed a problem with sending Maneuver Sequences for the Shuttle through the NCC in the Throughput Mode.

A Network Operations Discussions (NOD) meeting took place in Building 12 on August 17. The primary topic for the meeting was to discuss the S-band Multiple Access (SMA) capability which will be on TDRS H, I, J.

(continued on page 12)

(continued from page 11)

Information about the difference between Multiple Access (MA) and SMA was presented and the customers were introduced to what they might need to do to use this capability.

The Ground Network Scheduling System Replacement (GNSSR) is now operating in a shadow mode. In addition, the GNSSR report generator code was enhanced to process database files received from Wallops Flight Facility. Wallops now automatically transfers the database files using FTP to a stand-alone workstation within the NCC. This process enables Network Reporting to produce reports on the number of events and minutes of support scheduled by the Wallops scheduling office.

On July 19, Building 13 was evacuated due to a bomb threat in Building 14. The NCC received word to evacuate, then received word about five minutes later that the evacuation did not apply to Building 13. Most of the NCC personnel had departed the building prior to the evacuation being rescinded. Some key personnel were allowed to return immediately, and there was no impact to operations.

Operations personnel attended a presentation on July 21 on the NASA Security Campaign. Information was presented on the threats to security and the steps NASA is taking over the next two years to counter those threats. The NCC will take action to step up the security awareness of all of the NCC personnel via increased local training and continued review of our practices and policies.

In addition to the activities described above, the NCC supported nine Expendable Launch Vehicle (ELV) launches and one Space Shuttle mission since June 1, 1999. The NCC also continues to develop NCC Year 2000 (Y2K) contingency plans and is participating in the GSFC Mission Services Program Y2K Business Continuity and Contingency Plan (BCCP) team.

By Joe Snyder/ATSC

For further information, please contact Bill Webb/GSFC Code 451 at (301) 286-3264 or visit http://ncc.gsfc.nasa.gov on the World Wide Web.

Mission Services Program Customers

Hubble Space Telescope Prepares for Third Servicing Mission

Hubble Space Telescope (HST) personnel remain quite busy this season as they prepare for the upcoming third servicing mission. This mission was actually split into two separate missions, SM3A and SM3B, which are scheduled for launch aboard the Shuttle on December 2, 1999 and mid-2001, respectively. NASA decided to split the third mission after an HST gyroscope failed recently. HST is equipped with six gyroscopes, and the recent failure left only three functioning gyroscopes—the minimum needed to conduct science operations successfully. If another gyroscope were to fail, HST would enter a "safe mode," disallowing any further science observations. NASA officials decided to have the astronauts replace the gyroscopes during the already-scheduled third servicing mission. Subsequently, they divided the mission into two parts to reduce the workload on each.

In addition to restoring HST's full complement of gyroscopes, astronauts will be installing and repairing a number of HST components during the four extra vehicular activities scheduled for SM3A. They will fix door latches in the aft of HST that have been damaged by extreme temperature changes and high torque. A digital Solid State Recorder (SSR) will be installed, replacing the last of the two original reel-to-reel mechanical data-tape recorders. The SSR can record ten times as much data as the original mechanical recorders. Astronauts will also replace one of the three Fine Guidance Sensors (FGS) with a refurbished model, and exchange HST's main computer with an advanced model that is twenty times faster and has six times as much memory as the current model. In addition, Shell/Shield Replacement Fabric (SSRF) and New Outer Blanket Layer (NOBL) will be installed in damaged areas, a new S-band Single Access Transmitter (SSAT) will replace the older unit, handrail covers will be fitted to protect HST against damage from peeling paint, and Voltage/Temperature Improvement Kits (VIKs) will be installed to protect HST's batteries from overcharging.

On the science front, HST continues to produce a wealth of useful science data resulting in fascinating discoveries. Two independent teams recently used HST to glean clues about the formation of galaxies. Galaxies are composed of a bulge consisting of millions of stars, surrounded by a less-populated disk of stars. The central bulge controls the rate of star birth and development of a galaxy. These two independent HST surveys confirmed that the bulges in some galaxies formed early, while others formed quite slowly. Using HST

observations, Reynier Peletier from the University of Nottingham in the UK ascertained that tightly wound spiral galaxies have bulges that were created at the same time early on in the universe. A team led by C. Marcella Carollo of Columbia University in New York found that galaxies with small bulges, including bar-like structures, developed more recently. Before the advent of HST, astronomers could only make such observations about our own galaxy. The precise resolution of HST's visible light and infrared cameras allowed these scientists to view other galaxies and determine the ages of their cores.

This article was composed from information located on the WWW at sites http://hubble.gsfc.nasa.gov and http://oposite.stsci.edu. Check out these locations for additional HST news.

EUVE: 7+ Years and Still Going Strong

Operations for NASA's Extreme Ultraviolet Explorer (EUVE) mission at U.C. Berkeley's (UCB) Center for EUV Astrophysics (CEA) continue to be characterized by rapid change: new scientific observations and discoveries, spacecraft anomalies, additional engineering improvements, stomping out the millennium bug, and continual technology "testbedding." The Project reached another major milestone when, on 7 June, it celebrated its 7-year launch anniversary with a party attended by over 50 current and ex-EUVE employees. A good time was had by all, as hand-held rockets were "lit up" to reenact the EUVE launch from a simulated Kennedy Space Center pad 17A!

Of course, EUVE's main focus remains on science, and there has been a lot of activity in this area over the past few months. Using EUVE spectra of the cataclysmic variable binary star system AR UMa, Dr. Steve Howell (Planetary Science Institute) compiled the first-ever time-resolved EUV spectroscopy and radial velocities for any star. These spectra reveal a complex helium emission that changes in both strength and profile as a function of the system's orbital phase, suggesting that the source of the emission is near the inner heated portion of the accreting gas stream, and not in the secondary star as was previously thought.

Also, Dr. Denis Leahy (University of Calgary) used EUVE imaging data to study the binary system Her X-1. Dr. Leahy compiled a 4.1-day light curve that covers 2.4 cycles of the system's 1.7-day orbital period (see Figure 1). These data confirm the 35-day rotation period of the system's accretion disk, and reveal an x-ray "shadow" that the disk casts on the

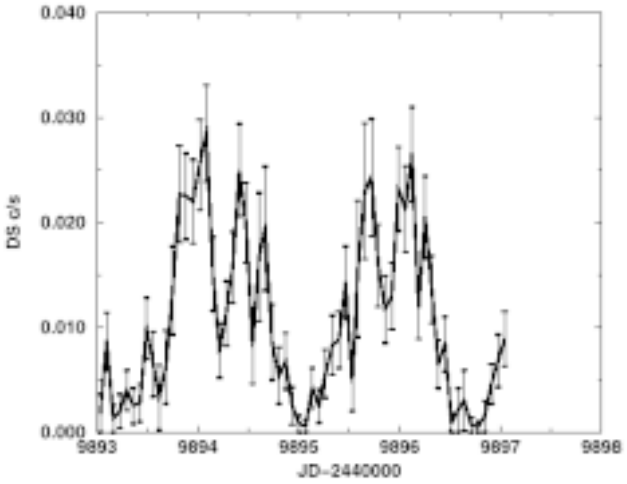

Figure 1. EUVE Deep Survey telescope light curve of the x-ray binary Her X-1 over a 4.1-day period, covering 2.4 cycles of the 1.7-day orbit of the neutron star around its two-solar-mass A-type companion star.

companion star (the binary's neutron star is the source of the x-rays).

And surprisingly, Dr. Jules Halpern (Columbia University) reported the serendipitous discovery of the highly magnetic cataclysmic variable system EUVE J0425.6-5714, which was unexpectedly detected in Dr. Halpern's December 1997 observation of the active galaxy 1H 0419-577. The EUVE light curve (see Figure 2) clearly shows the system's 86-minute orbital period, as well as indications that the accretion stream is eclipsing the emitting region on the surface of the

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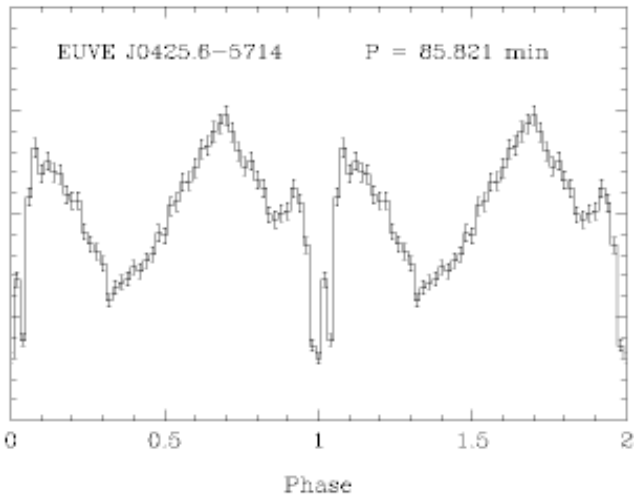

Figure 2. Folded, background-subtracted light curve of the newly discovered AM Her-type cataclysmic variable system EUVE J0425.6-5714 as seen in the EUVE Deep Survey imaging detector.

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system's white dwarf star. Information on these and other EUVE science highlights are available on-line at *http://www.cea.berkeley.edu/~science/html/Resources_high.html*.

In July, the EUVE Science Advisory Board (ESAB), which NASA established to provide independent oversight of the EUVE mission on behalf of the science community, submitted its FY98 report on CEA's operations of the EUVE mission. The report outlined the mission's important recent science highlights and commended the CEA staff for their excellent efforts in providing high science value given the small annual operations budget (~$1 million). This report is available on-line at *http://www.cea.berkeley.edu/~pubinfo/html/whatsnew.html.*

In August, the EUVE Project released to the science community a call for proposals for observations during Cycle 8 of the EUVE Guest Observer Program. Final proposals are due in mid-October and are again being accepted through CEA's Web-based electronic proposal submission system, with observations scheduled to begin in March 2000.

Both the EUVE spacecraft and science payload continued to perform extremely well, with the science data return rate over 99%. During the past quarter EUVE conducted 31 separate pointings of 21 individual celestial targets.

Recent operations, however, have produced a few anomalies that have livened things up for the EUVE Flight Operations Team (FOT):

- On 3 June the on-board computer detected an overspeed condition with the High-Gain Antenna Pointing System (HGAPS). HGAPS was subsequently disabled in response to this condition. The anomaly resulted from slewing during a real-time contact with the spacecraft, something that is generally avoided but was necessary in this particular situation.

- On 24 June the NCC paged FOT engineers because of back-to-back negative acquisitions with the spacecraft. This anomaly was the result of operator error: the inadvertent loading of an old antenna gimbal angle table caused the spacecraft to enter "empty-table track" mode in which, by default, it tracks on TDRS-West, while the events in question were scheduled on TDRS-East!

- On 31 July the EUVE spacecraft entered "orbit setback mode," which was caused by the expiration of the on-board ephemerides. This anomaly was the result of CEA's first implementation of ephemerides that had been "stretched" to their maximal 72-hour lifetimes in order to accommodate fully unstaffed weekends (see below). Unfortunately, a subtle error caused these tables to expire about 30 minutes early, which prompted the orbit setback condition.

In all of the above anomalies, the FOT quickly diagnosed and corrected the problems with no negative impacts to science or operations.

When not conducting routine operations or responding to anomalies, the FOT continued to implement engineering improvements. After fixing the above-mentioned subtle ephemeris error, on 14 August CEA discontinued Saturday staffing of the control center. EUVE is now on a schedule of single-shift Monday-Wednesday-Friday real-time operations with Tuesday-Thursday off-line operations and fully unstaffed "lights-out" weekends.

EUVE engineers also continue to actively improve the performance of the three on-board batteries. On 18-19 August the FOT reconditioned these batteries, allowing them to discharge over a three-orbit period to the ~75% state-of-charge (SOC) level (normal SOC is ~92%), and then to fully recharge over the subsequent two orbits. This reconditioning was conducted successfully and without incident. As a result, power system performance has improved, showing reduced differential voltage levels and more equal load sharing between the batteries.

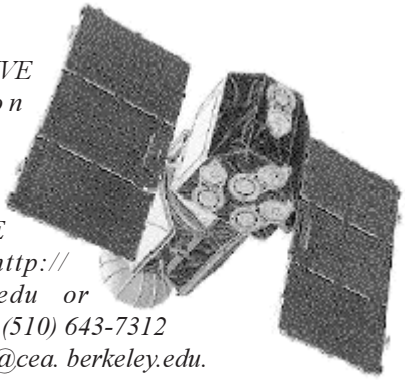
Also, at the request of a guest observer, in September EUVE engineers conducted a feasibility study for a possible EUVE observation of the planet Mercury, which would be the first-ever full view of that body in the EUV. The FOT's preliminary findings, which are based on EUVE's successful observation of Venus in April 1998, suggest that a Mercury observation is most likely doable, albeit very difficult. We hope and look forward to receiving and implementing a Mercury-related proposal in Cycle 8!

And, of course, one cannot forget about the infamous Year-2000 (Y2K) problem. The FOT has worked hard to ensure that all mission-critical systems will be Y2K-compliant by October. GSFC has implemented the required software changes for the outsourced spacecraft command-and-control systems, and has been delivering those changes to the FOT for final release and testing. CEA has also completed Y2K work on its in-house science payload and data archiving systems. A full end-to-end test of all systems is scheduled with numerous GSFC elements on 19 October.

Finally, CEA continues to actively support a number of technology testbed projects. For the past few months the EUVE Power Engineer, Mark Lewis, has played a major role in leading the outsourcing from GSFC to UCB's Space

Sciences Laboratory (SSL) of spacecraft operations for the Fast Auroral Snapshot Explorer (FAST) mission, with the official handover scheduled to occur on 11 October. EUVE is also gearing up to provide engineering support for Integration and Test operations for SSL's High Energy Solar Spectroscopic Imager (HESSI) Project. On another front, EUVE programmers continue to work on the Remote Tools for Engineers (RETOOLE) software project to provide EUVE telemetry data via the Internet; a working beta version that provides access to real-time EUVE telemetry is undergoing internal testing.

So, after 7+ years in orbit, the EUVE flight systems continue to perform extremely well and we look forward to many more years of operations. The EUVE Project at CEA continues to challenge us all, keeping work interesting, exciting, and fun.



By Brett Stroozas/EUVE Project/Mission Manager

For more information, visit the UCB/EUVE WWW site at http://www.cea.berkeley.edu or contact the author at (510) 643-7312 or via email at bretts@cea. berkeley.edu.

Long Duration Balloon Program Update

The Long Duration Balloon Program (LDBP) was anticipating another northern hemisphere flight from Fairbanks, Alaska last June. The Russian Government, however, had other plans. For reasons not quite understood, the Project was denied an overflight of the Russian continent. Unfortunately, the campaign was shut down.

The science experiment that was to fly in Fairbanks in June was readied and reintegrated in August for a trip to Antarctica. It will be the next LDBP TDRSS flight and is scheduled for early December 1999.

The scientific experiment to be flown is a collaboration between the University of California at Berkeley and the University of Washington. They will be flying detectors that will study auroral X-rays in the MeV range.

The LDBP expects to have one or two northern hemisphere flights from Fairbanks, Alaska in the May/June 2000 time frame. Two flights are also planned in Antarctica in December 2000 as well as one or two flights in Australia in January 2001.

By Bryan Stilwell/NSBF/Physical Sciences Laboratory, NMSU

For additional information, please contact the author at (903) 723-9097, or via email at Stilwell@master.nsbf.nasa.gov

Compton Gamma Ray Observatory Flight Operations Team Gets the Satellite Back on Its Feet

Launched in April 1991 by the space shuttle Atlantis, the Compton Gamma Ray Observatory (CGRO) continues its successful operations, now well into its ninth year in orbit. The spacecraft and its various subsystems are continuing to function nominally.

Recently, an anomaly involving pointing of the high-gain antenna system was cause for a great deal of concern. The antenna was not responding properly to commands issued to point it at the TDRS for high-speed data transmission. Command of the spacecraft, and basic health and status information were available via the omni-directional low-gain antenna system, but the data rate supported by that system is inadequate for normal science operations. Normal mission operations, therefore, had to be suspended while the problem could be studied.

A team comprised of current and former members of the Flight Operations Team (FOT) was assembled on short notice, and a number of tests were performed to diagnose the problem. It became evident, after a few rather anxious days, that there was indeed no mechanical or electrical problem—the antenna did not seem to be slewing in an erratic manner or ignoring commanding altogether—rather, it was slewing to a point on the sky other than the desired one.

Further analysis yielded more insight. The antenna position is updated over the course of a spacecraft orbit so that it points at or "acquires" the TDRSS element most optimal for viewing during that orbital segment. It became apparent that the antenna pointing system was, in a consistent manner, attempting to acquire the TDRSS element for a previous

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orbit segment rather than for the current one. This was strongly suggestive of a software bug, an errant uplink of command parameter tables, or some combination thereof.

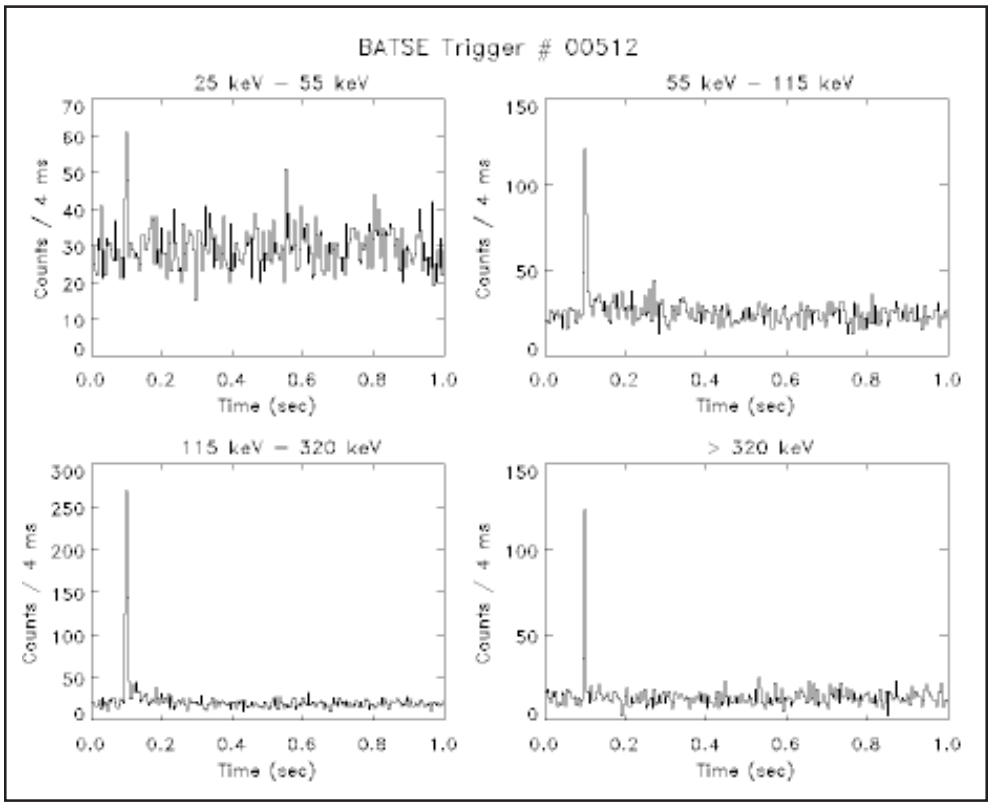
Eventually, it became clear that the antenna system command parameter tables were not updating properly. A "work around" to the problem was quickly devised, but the team decided not to resume normal operations until the underlying source of the problem was determined. After further study, the puzzle was solved. The problem was the result of an improbable combination of a normally benign human error and a subtle flight software bug introduced in 1993 following the enhancement of TDRSS support of CGRO. Once this problem was understood, the software could be easily fixed, and recurrences of the problem avoided. Remarkably, the net effect of this anomaly resulted in the loss of less than one week of science data! Those of us on the scientific side of the mission are extremely gratified by the thoroughness and efficiency with which the CGRO FOT was able to handle this situation, particularly in lieu of staff "downsizing."

Problems aside, CGRO then continued its mission of studying the high-energy universe. A recent measurement, based on data from the Burst and Transient Source Experiment (BATSE) instruments, provides an example of its continued scientific productivity.

A cornerstone of modern physics is the invariance of the speed of light, first postulated early in this century by Albert Einstein. Recent alternative theoretical work attempting to link Quantum Theory to theories of Gravitation suggests that there may be an energy dependence on the speed of light. That is to say, that for example, that light quanta (or photons) emanating from a distant source may reach an observer at different times, depending on their wavelength, or energy. These differences must be quite small in order to have eluded measurement to date—indeed experimental limits of one part in 10^8 (100 million) on light-speed variations already exist.

It was recently pointed out by scientists at Yale University, led by Dr. Bradley Schaefer, that this measurement could be improved if a distant source emitting over a broad energy range with a well-defined pulse profile could be identified. We now know (from previous studies using CGRO in conjunction with other ground and space-based observatories) that gamma-ray bursts are, for brief periods of time, the most luminous objects in the universe. They also are very distant from earth—typically a billion light years or more. Nonetheless, their temporal properties are erratic, and have eluded simple classification schemes. Several events, however, have been identified with very sharp temporal structures (see the accompanying figure). By measuring the precise peak of one such pulse at different energies, one can place constraints on the possible energy dependence of the speed of light.

The results for several gamma-ray bursts detected by BATSE suggest that the speed of light is independent of energy to a precision of



Example of a gamma-ray burst with a particularly sharp initial pulse. The four panels indicate the behavior over different energy bands. The precise shape of the pulse at different energies, particularly the occurrence time of the peak, can be used to constrain possible variations in light speed with energy.

about one part in 10^{20}. This result represents a dramatic improvement—a factor of 10^{12} (one thousand billion) over previous limits! Thus, unless these results are later refuted, it appears that Einstein was right—the speed of light is constant to an extremely high degree of precision—and CGRO has made a contribution to our understanding of a very basic aspect of modern physics.

By Chris R. Shrader/Compton Gamma Ray Observatory Science Support Center, NASA GSFC

For additional information refer to http://cossc.gsfc.nasa.gov on the World Wide Web.

Tropical Rainfall Measuring Mission: Autumn '99 Status

The Tropical Rainfall Measuring Mission (TRMM) spacecraft has remained in good health and virtually problem free since our last report. All personnel associated with the mission were pleased to learn that TRMM science data aided researchers in proving that smoke from forest fires does, in fact, inhibit rainfall. These findings were published in the 15 October issue of Geophysical Research Letters and stated in NASA Press Release 99-110.

As for upcoming events, there are two periods which will demand planning and support other than the ordinary: the Leonid meteor storm in mid-November and the Year 2000 (Y2K) rollover at the end of the year. For the Leonids, TRMM plans to use the same scenario from 1998, whereby instruments will be turned off for a predetermined time, while maintaining a nominal flight attitude with engineering personnel on-hand.

TRMM Y2K plans have been reviewed and testing completed. A Delta-V maneuver to place TRMM at a higher than normal altitude will be performed on or about 29 December to prevent the need to do another such maneuver over the January 1 weekend. Delta-V maneuvers occur every four to five days. Command fail-safes will be included in daily loads, and engineering support will be present. Please note that the above is subject to modification should conditions warrant.

Something which may be of interest to those readers on the Eastern seaboard is a depiction from TRMM data of rainfall intensity from the recent Hurricane Floyd. The picture was generated from the Precipitation Radar (PR) instrument, and is provided courtesy of the National Space Development Agency (NASDA) of Japan through the auspices of Dr. Christian Kummerow, GSFC Code 912, TRMM Project Scientist. It shows rainfall intensity at various locations around the storm's eye. The color version of this information is available on *The Integrator* web-site (*http://nmsp.gsfc.nasa.gov/integrator/*) and later, on the TRMM Project web page at *http://trmm.gsfc.nasa.gov*.

The status of the TRMM instrument package remains as stated in the July issue of *The Integrator*. Of the four healthy instruments, three [the Precipitation Radar (PR), TRMM Microwave Imager (TMI), and the Visible and Infrared Scanner (VIRS)] form the rain package, which provides the most complete rain data set used to generate climate models and perform severe storm studies. In this issue, the TRMM flight team would like to showcase PR which is an active radar instrument that continuously measures rain rate over the globe (both land and sea). It is the first quantitative rain radar of its kind to fly in space, and was developed and is maintained by NASDA.

Physically, PR is fairly large – being 2300 mm in length, 2305 mm in depth, and 720 mm in height. It is situated on the +Z (earth pointing) side of TRMM. PR measures the intensity of rain over a frequency of 13.8 GHz, while scanning a global swath 215 km wide. To support optimum data capture activities, the TRMM spacecraft is maintained in an orbit +/- 1.25 km of 350 km plus Earth equatorial radius. This altitude is maintained by planned Delta-V maneuvers utilizing an on-board thruster package to burn to the operational altitude. Two burns are done to pulse the spacecraft up the necessary 1.5 to 2 km. The second burn rounds out the orbit. Maintaining the orbit within the +/- 1.25 km aids in predicting ground crossings several weeks in advance.

PR operational health remains excellent. Very little commanding is required, save for an occasional calibration sequence. Its data, along with that from TMI, aids in increasing the understanding of worldwide rainfall distribution of both tropical and subtropical regions, rain profiles, and latent heat release. Because of this positive status, the outlook is very good for the TRMM instrument package, and PR in particular, to continue to provide meaningful science data for the several remaining years of mission life.

By Lou Kurzmiller/TRMM FOT

For additional information, please visit the TRMM web site at http://trmm.gsfc.nasa.gov, or contact John Grassel/ATSC at (301) 805-3167 or via email at john.grassel.1@gsfc.nasa.gov.

Earth Science Mission Operations Takes Control of Landsat-7

Since the launch of Landsat-7 (L-7) on April 15, 1999, observatory performance has been outstanding. On-orbit verification (consisting of an underfly of Landsat-5 for cross-calibration and one complete 16-day cycle after acquisition of the Landsat World Wide Reference system) was completed on July 15. The responsibility for Landsat-7 operations was turned over to the Earth Science Mission Operations (ESMO) Project on August 1.

ESMO (Code 428) is a new project. It was formed to operate Earth Science missions for NASA Headquarters, Code Y. It is operationally responsible for Landsat-7, TOMS EP, UARS, ERBE, and TRMM. There are a number of EOS-G satellites (TERRA, PM, Chemistry, etc.) in the queue that will be turned over to ESMO after launch and on-orbit checkout. Paul Ondrus is the ESMO Project Manager.

Since late June, Landsat-7 has been acquiring images per its Long Term Acquisition Plan. This plan maximizes our effort to acquire and archive a complete set of the earth's landmass three or four times a year. It prioritizes images to be acquired based on numerous factors (when last acquired, cloud cover, location, etc.) and schedules them for both acquisition and for downlink. All images except for those over the continental United States or Alaska, are recorded and downlinked at either the EROS Data Center (EDC) in Sioux Falls, SD; Alaska; or Norway. Data downlinked to Alaska and Norway is copied to tape and shipped to EDC for processing.

As of mid October, over 30,000 full scenes have been acquired and archived at the EDC Distributed Active Archive Center (DAAC). We have acquired at least one image of almost every piece of land on the earth. Scenes of the continental U.S. and Alaska are acquired on every pass so there is a very good selection of these available for purchase in the archive.

The EDC has also established working agreements with a number of international partners. Landsat data is downlinked daily to stations in Europe, Canada, Australia, and Argentina. A number of other stations will be on-line soon.

There is a Landsat-7 Image Gallery available on the web at *http://landsat7.usgs.gov*.

Ongoing Landsat-7 events:

- Landsat Science Team meeting – October 12-15
- Landsat Quarterly meeting– October 27
- Landsat-7 Inclination adjustment – Early November
- Landsat-7 Pecora Workshop – at the American Society for Photogrammetry and Remote Sensing conference in Denver, CO; December 6-10

By Ken Dolan/GSFC Code 430

For further information about Landsat-7, please visit the Landsat-7 home page at http://geo.arc.nasa.gov/sge/landsat/landsat.html, or contact the author at (301) 286-7962 or via email at Stephen.K.Dolan.1 @gsfc.nasa.gov.

Landsat-7 Team Receives Prestigious Award!

The American Institute of Aeronautics and Astronautics (AIAA) recently selected the Landsat-7 team to receive its annual Space Systems Award. The award recognizes outstanding achievements in the architecture, analysis, design, and implementation of space systems. Landsat-7 Government and contractor team representatives traveled to the AIAA Space Technology Conference and Exposition in Albuquerque, NM to receive the award, which was presented on September 28.

Congratulations!

TOPEX/Poseidon Enables New Applications for Satellite Altimetry

TOPEX/Poseidon continues to provide scientists with exciting and unique measurements of sea surface conditions worldwide as the mission continues into its eighth year of successful operations. In early September, the satellite experienced a relatively serious safehold anomaly due to a central data processing unit reset. Through outstanding teamwork and exceptional TDRSS network support, we were able to safely return to normal operations after a brief recovery phase.

Although TOPEX/Poseidon has become well known for providing El Niño and La Niña images of the Pacific, some new and interesting applications have been enabled by the mission altimetry data. These include:

Ship Routing and Ocean Monitoring for Offshore Industries

Ocean features such as currents and eddies are mapped by mariners to either avoid or take advantage of water-flow direction. These maps are now incorporating TOPEX/Poseidon data, and are being used in commercial shipping and competitive sailing to optimize routes from one destination to another. Knowledge of such features is also assisting undersea cable laying and repair operations, which require accurate knowledge of ocean circulation patterns to minimize impacts of strong currents on cable ship and robotic underwater vehicles.

Ocean Debris Tracking

Marine debris such as nets, timber, and old ship parts collects in locations based on wind and currents. This ocean "junk" can physically destroy coral, entangle marine mammals, and be a navigation hazard to small vessels. The potential of utilizing TOPEX/Poseidon to help identify likely locations of marine debris will be tested near the coral reefs of the Hawaiian Archipelago by a research group in early 2000.

Fisheries Management

Applications in development in this area include satellite-derived tools to monitor and assess coral reef ecosystems and fish habitats. A recent study focused on use of altimeter-derived geostrophic currents to model and predict repopulation success of spiny lobster larvae in the central Pacific.

Hurricane Forecasting

Heat content of the ocean is derived from the altimeter data, and plays a vital role in the development and intensity of hurricanes. Altimeter data is being incorporated into complex atmospheric models, which are being used to both predict hurricane season severity and forecast individual storm intensity. Relationships about the amount of heat in the upper ocean as storms pass over these regions are also being formulated.

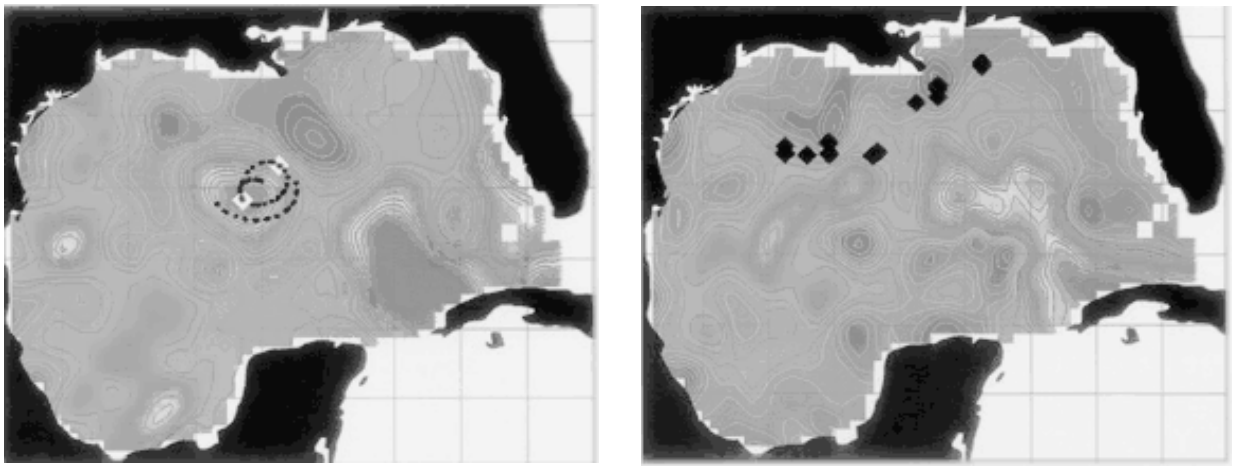
Cetacean Habitat Monitoring

Scientists have learned that sperm whales are more abundant in ocean eddies and other habitats where nutrients and plankton are plentiful. These locations are tracked and mapped using altimeter data, which are subsequently used by scientists to plan and optimize cetacean research cruises.

The Project is looking forward to continued mission success over the next year. Although the satellite is currently operating with several degraded or failed hardware systems, we have been able to substitute redundant components or design operational alternatives in all cases. Our engineering team continues to remain optimistic that the satellite will remain healthy through next year's launch of Jason-1, the follow-on mission to TOPEX/Poseidon.

By Mark Fujishin/Mission Manager, TOPEX/Poseidon Project

More information about the TOPEX/Poseidon spacecraft is available on the WWW at http://topex-www.jpl.nasa.gov, or contact the author via email at Mark.Fujishin@jpl.nasa.gov.



Example of maps incorporating TOPEX/Poseidon altimetry data to study sperm whale habitats in the Gulf of Mexico. Mapped eddies flow along the contour lines, while whale sightings are shown as black diamonds.

Small Explorer Program Highlights

SAMPEX and FAST Ground Data System Re-engineering Completed

The Small Explorer (SMEX) Ground Data System (GDS) re-engineering effort, initiated in part by the drive for all missions to be Year 2000 compliant, has been finalized. The command and control software for the Fast Auroral Snapshot Explorer (FAST), and the Solar Anomalous and Magnetospheric Particle Explorer (SAMPEX) was transitioned from the Transportable Payload Operations Control Center (TPOCC) software system to the Integration, Test, and Operations System (ITOS). ITOS is a variation of the software that was used in integration and test for SAMPEX and FAST, and it was chosen as the operational command and control software for the remaining SMEX on-orbit missions [Submillimeter Wave Astronomy Satellite (SWAS), the Transition Region and Coronal Explorer (TRACE), and the Wide-Field Infrared Explorer (WIRE)] when they were in the development phase.

The SMEX Mission Operation Center (MOC) is a multi-mission facility that is currently capable of supporting SAMPEX, FAST, TRACE, WIRE, and SWAS and is preparing for the Triana mission. The MOC is staffed for a single daytime shift, and the Flight Operations Team (FOT) members are cross-trained among the various missions. Members of the SMEX FOT normally support SAMPEX from the Bowie State University Satellite Operations Control Center (BSOCC). Since all the SMEX missions are now operated using the same software system, opportunities exist for greater flexibility of both FOT staffing and mission operations approaches.

FAST Flight Operations Team Responsibilities Transitioned to the University of California at Berkeley

Flight Operations for the Fast Auroral Snapshot Explorer (FAST) were transferred from a GSFC-based Flight Operations Team (FOT) to the University of California at Berkeley (UCB), following a successful Operational Readiness Review (ORR) held at GSFC on October 4, 1999. The ORR was the culmination of a series of activities associated with the transfer. The FAST GDS software elements were provided to UCB in April 1999 following the successful re-engineering from TPOCC to ITOS. This system was then integrated and tested using both test data and actual spacecraft engineering contacts. The testing was coordinated with all elements of the GDS: the FOT, mission planning, flight dynamics, science data processing, network scheduling, and the ground network antennas at Wallops Island, Virginia; Poker Flat, Alaska; and McMurdo Ground Station, Antarctica. In addition to the integration and test activities, intense training was provided for two UCB flight operations team members. These two UCB employees trained at Goddard with the FAST FOT for two months, and were certified as both command controllers and spacecraft analysts for FAST.

The flight operations responsibilities join the science operations already at UCB. The principal investigator for the FAST mission is Dr. Charles Carlson in the Space Systems Laboratory (SSL) at UCB. The next Small Explorer satellite mission expected to launch is the High Energy Solar Spectroscopic Imager (HESSI). The principal investigator for HESSI is also associated with the SSL. FAST and HESSI operations will occupy the same Mission Operations Center (MOC) and utilize the same GDS architecture. The experience gained from the routine operation of FAST from the UCB MOC should provide considerable benefit to the HESSI team as it prepares for its own launch and on orbit operations. Eventually, FAST and HESSI will benefit from the economies of operations within a multimission facility, similar to that found at the GSFC SMEX MOC.

WIRE Testbed Project Open for Business

The primary objective of the Wide-Field Infrared Explorer (WIRE) was lost when the instrument aperture cover deployed prematurely soon after launch. The second phase of the mission began in July 1999 and is currently in progress. The WIRE Testbed Project is currently open for business, and is accepting proposals to perform residual science experiments, validate new technologies, verify new operations concepts that may enable reduced future mission operations costs, and to perform educational outreach.

WIRE is a three-axis stabilized spacecraft in a sun synchronous low earth orbit. The satellite has star tracker pointing accuracy, a full complement of gyros, and is controlled using reaction wheels and magnetic torque rods. Modification to the flight software may be permitted, provided the health and safety of the satellite is maintained.

The first Testbed experiment, astroseismology, used the star tracker normally used for pointing control, to make the first detection of multimodal oscillations in a cool star. An article about this experiment may be found at: *http://cnn.com/TECH/space/9908/04/space.salvage*. A second residual science experiment, stellar variability, also uses the star tracker as a scientific instrument. The WIRE Testbed Project is currently pursuing flight software modifications to enable the test of an onboard finite state model for spacecraft monitoring and control, and a test of a new satellite safehold algorithm. Tests to evaluate the on-orbit performance of the star tracker and its shades are under review. Additionally, the WIRE testbed is currently negotiating with a few commercial providers of ground station networks to support their station validation.

The sponsors of the individual tests fund the WIRE Testbed. Investigators interested in using the WIRE Testbed may contact Jacqueline Mims (Project Manager) at (301) 286-0803 or Patrick Crouse (Mission Director) at (301) 286-9613 to obtain additional information, or visit the web-site *http://sunland.gsfc.nasa.gov/smex/wire/wire_testbed.html*

By Patrick Crouse/GSFC Code 581

For additional information, please visit http://sunland.gsfc.nasa.gov/smex/smexhomepage.html on the WWW, or contact the author at pcrouse@pop500.gsfc.nasa.gov, or via telephone at (301) 286-9613

QuikSCAT: Getting the Job Done

NASA's Quick Scatterometer (QuikSCAT) was lifted into space on Saturday, June 19, 1999 from Vandenberg AFB, CA. The satellite was launched in a south-southwesterly direction, over the Pacific Ocean to achieve an initial elliptical orbit with a maximum altitude about 800 kilometers (500 miles) above the Earth's surface. Approximately an hour into flight, QuikSCAT deployed its solar arrays. Immediately following deployment of the solar arrays, the tracking station at Svalbard, Norway acquired the first signal from the spacecraft.

During the next two weeks, QuikSCAT fired its thrusters as many as 25 times to circularize and gradually fine-tune its Sun-synchronous, 803 km, 98.6 degree of inclination orbit. Following the firing of the thrusters, the scatterometer science instrument, SeaWinds on QuikSCAT, was turned on for the first time. Members of the project engineering and science teams spent the next 13 days performing detailed checks of the instrument and calibrating its radar backscatter and ocean wind measurements. Although calibration and validation of the measurements will continue for several months, QuikSCAT has begun its primary mission of mapping ocean wind speed and direction.

With its broad, 1,116-mile wide swath and all-weather observing capabilities, the SeaWinds instrument is providing extraordinary, frequent, surface wind speed and direction measurements over the global oceans. Two demonstrations of QuikSCAT's observing capabilities include measurements in the Pacific Ocean and in the China Sea.

Figure 1. Titan IV Launch Vehicle

Figure 2. Image of Hurricane Dora

On August 10, 1999, the SeaWinds instrument captured an image of Hurricane Dora in the eastern tropical Pacific Ocean and measured wind speeds of nearly 90 miles per hour. Figure 2 is an image of Hurricane Dora showing the high surface wind speed in the center and the wind direction (shown by arrows) in the vicinity of the hurricane.

On July 28, 1999, SeaWinds also captured an image of Typhoon Olga in the China Sea. As the storm's intensity grew, wind speeds of more than 57 miles per hour were measured as Olga delivered torrential rains to South Korea, North Korea, and other countries of south Asia. A news article (*http://winds.jpl.nasa.gov/news/olga.html*) discussing the benefits of the QuikSCAT observation of Typhoon Olga reports the assessment of the QuikSCAT project scientist at NASA's Jet Propulsion Laboratory, in Pasadena, CA. "SeaWinds is allowing scientists to determine the location, structure, and strength of these tropical depressions, typhoons, and severe marine storms very quickly as they develop," said Dr. Timothy Lie.

QuikSCAT will continue to monitor and study weather patterns including storm warnings, rain forest changes, global climate changes, and rain phenomenon for the next two years. Currently, all spacecraft subsystems and ground systems are operational and performing nominally.

By Vinny Patel/BA&H

For additional information, visit the Internet site at the following URL: http://winds.jpl.nasa.gov/missions/quikscat/quikindex.html or contact Raymond Pages/GSFC Code 581.2 at 301-286-6012.

Expendable Launch Vehicle News: Sea Launch First Commercial Mission A Total Success!

The launch of Sea Launch/DIRECTV R-1 took place on Saturday, Oct. 9, 1999. The DIRECTV 1-R direct broadcast satellite was launched into orbit from the Sea Launch equatorial launch site at 154 degrees west, zero degrees north. Launch occurred from the Odyssey, a self-propelled launch platform at 10/0328Z. The launch was supported by the Sea Launch Commander, a floating mission control center, which was positioned three miles from the Odyssey. TDRSS provided return telemetry for both the Zenit vehicle and the Payload Unit (PLU).

The Sea Launch program is a multinational partnership that uses a Russian-developed launch system aboard a converted oil rig to launch high-mass satellites from a location on the equator near Christmas Island in the Pacific. Launching at sea from the equator provides several performance advantages for payload capacity and launch inclinations, as well as reductions in the need for a traditional range.

Sea Launch left port in Long Beach, CA during the last week of September for the 10-11 day trip to the launch location. Following arrival at the launch site, the Odyssey was partially submerged to add stability to the launch platform. For launch, the launch vehicle was moved from its hangar on Odyssey and lifted into a vertical position prior to being fueled. Sea Launch uses a combination of kerosene and liquid oxygen for fuel. Additional information on Sea Launch is available on their web site at *http://www.boeing.com/defense-space/space/sealaunch/index.html* and additional information on DIRECTV is available at *http://www.directv.com*.

Encapsulated DIRECTV Satellite During

After three consecutive mission failures for the Air Force Titan IV, the Program took a giant step forward with the successful launch of a Titan IV B rocket from Vandenberg Air Force Base, CA on May 22. This launch paves the way for the next TDRSS supported Titan IV B launch, which is tentatively scheduled for December 11. The December mission will carry the Defense Support Program-20 missile warning satellite, and IUS-22 into space. Launch time has been set for 6:21 p.m. EST from Complex 40 at Cape Canaveral Air Station, FL. The Titan IV Program has an additional 10 missions scheduled during the next two years.

Atlas 2AS has resumed launch support with the successful launch of AC-155/EchoStar-5 on September 23, 1999. EchoStar, with a Centaur upper stage, was launched from Cape Canaveral Air Station, FL at 2:02 a.m. EDT. EchoStar-5 is expected to become operational in early November following checkout. Two additional Atlas 2AS launches are planned for later this year. AC-141 will carry the TERRA (formerly EOS AM-1) spacecraft aloft from Vandenberg Air Force Base, CA. Launch is planned for late November or December of this year. AC-156/ICO is also planned for the fourth quarter of the year. The launch of Atlas 2AS with the next generation TDRS-H from the Eastern Range has slipped into the first quarter of 2000.

Following several ELV anomalies earlier this year, the Atlas 3 Program lost the TELSTAR-7 payload to Arianespace. Originally scheduled to launch in July, the Atlas 3 inaugural flight date has not been reset.

In January of 2000, the Space Network (SN) and TDRSS will support the Orbital Sciences Pegasus XL launch of NASA's High Energy Transient Explorer-2 (HETE-2). The spacecraft will be staged from the Kwajalein Missile Range and support will be provided through ground based P-3 equipment located at the Kwajalein Range using a TDRS relay.

On July 7-9, representatives from the Boeing Company traveled to GSFC for the first Delta IV/TDRSS Interface Technical interchange meeting. Delta IV is an Evolved Expendable Launch Vehicle that will be capable of small, medium, and heavy payload launches. Initial launches will be small and medium payload classes beginning in April 2001. TDRSS will support launch vehicle telemetry following ground station loss of signal. Current projections are for an average of 17 launches a year—13 commercial and 4 government. Most launches will be from Cape Canaveral Air Station, FL, with an average of two launches a year from Vandenberg Air Force Base, CA. The first Vandenberg launch is projected for June 2002. A second Technical Interchange Meeting is planned for January 2000.

A new web page for Mission Services Program Office support of ELVs has been developed and is viewable at *http://nmsp.gsfc.nasa.gov/elv/*. This web site will be used to support the various interfaces involving TDRSS support to ELVs. Numerous links are provided to companies and other elements involved in ELVs, as well as SN disciplines that provide support.

By Joe St John/LMSC

For additional information, please contact Ted Sobchak via email at Ted.Sobchak@gsfc.nasa.gov or via phone at (301) 286-7813.

Additional Activities of Note

Space Network Adding Capability to Provide Ground Network-Type Services

The unfortunate loss of the Lewis mission (which was due to an anomaly that went undetected between ground station passes shortly after its launch) has resulted in an enhancement to the Space Network that will enable commanding via TDRSS for missions with signal designs previously considered incompatible with TDRSS. In response to the Lewis emergency, White Sands Complex (WSC) engineers implemented a temporary subcarrier modulator using spare parts and test equipment interfaced to the WSC S-Band Single Access forward modulators. The modulator firmware was modified to provide a frequency sweep for the command signal in an attempt to capture the Lewis transponder.

Even though the Lewis rescue efforts did not succeed in saving the spacecraft, the value of the SN subcarrier modulation commanding capability was firmly established. Development was initiated to provide this new type of service in an integrated and automated fashion.

In October 1998, NASA's Far Ultraviolet Spectroscopic Explorer (FUSE) mission began to express a growing desire to have the Space Network (SN) provide S-Band command services using subcarrier modulation. Several factors made SN commanding desirable to FUSE, among them, an approximate seven-hour gap in ground station coverage after the second orbit, extensive damage to their prime ground station in Puerto Rico caused by Hurricane Georges, and the recent failure of the Lewis mission. Unfortunately, the WSC development schedule for the planned integrated and automated service was not compatible with the FUSE launch schedule. Despite the schedule incompatibility, WSC engineers responded to the call and developed a mission-unique launch and early orbit capability for FUSE. Pre-launch testing with the FUSE spacecraft successfully demonstrated compatibility. The launch and early orbit phases were successfully supported by WSC using the SN on June 24, 1999. Permanent and automated modifications to the WSC hardware, software, and firmware will provide subcarrier and direct carrier modulation for each of the S-Band Single Access forward services, including a ground station-like "uplink sweep." This Space Network enhancement is expected to be completed in the first quarter of 2000.

By Bryan Gioannini/WSC Code 451

For additional information on this topic, please contact the author by email at Bryan.Gioannini@gsfc.nasa.gov or by telephone at 505-527-7002.

TILT Travels the World

On August 11, 1999 the TDRSS Internet Link Terminal (TILT) was on board the Royal Olympic Countess cruise ship in the Black Sea, providing a 1.024 Mbps Internet link for the NASA webcast of the Total Solar Eclipse. Just over a month later, on September 15, President Clinton, himself, was in New Zealand using TILT to videoconference with McMurdo Station in Antarctica.

The TILT S-Band system is comprised of two rack-mounted shipping containers and an antenna. Once powered up, it uses its own Global Positioning System (GPS) capabilities and knowledge of the TDRS position to automatically keep the antenna pointed. TILT customers connect to the TILT

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router/hub for complete Internet access—anything you can accomplish from your office LAN connection is possible through TDRSS.

For the Eclipse 99 support, TILT provided the Internet link enabling access to real-time images from the last total solar eclipse of this century. The Operating Missions as Nodes on the Internet (OMNI) project's equipment provided weather and imagery data through the link. Many schools and museums, including the Maryland Science Center in Baltimore, participated in live viewing of the eclipse. Participants at these selected institutions were able to conduct chat sessions with scientists and even to control a camera on board the ship using the Internet provided by TILT.

The TILT equipment was back at GSFC for only a couple of weeks when the National Science Foundation (NSF) called to use the TILT for the President's visit to the International Antarctic Centre. The TILT system design is based on that of the South Pole TDRSS Relay (SPTR), which provides a daily high data rate Internet connection to the South Pole. This past season, the SPTR provided the critical link for videoconferencing to the South Pole, allowing a doctor, who was marooned there due to winter weather conditions, to communicate with specialists concerning the discovery of a cancerous lump in her breast. Using SPTR-enabled videoconferencing, doctors in the U.S. were able to explain procedures that could be implemented (including chemotherapy) to begin treating the cancer until the patient could be evacuated. The TILT videoconferencing by the President demonstrated how this link was accomplished.

TILT is back at Goddard, where it will be used to test the White Sands Alternate Relay Terminal (WART). In December, TILT will be in Pipestem Park, WV supporting an educational outreach program linking local students with students at Yosemite National Park through the Internet via TDRS. Students at DuVal High School in Greenbelt, MD, along with students in Salt Lake City, UT and Lake Placid, NY will be able to access the data on the Internet.

Look for information about future adventures of TILT in the next issue of *The Integrator*!

By Dave Israel/GSFC/Code 567

For additional facts about TILT, please visit http://rodent.gsfc.nasa.gov/tilt/ on the WWW, or contact the author at (301) 286-5294 or via email at David.Israel@gsfc.nasa.gov.

TILT equipment on the deck of the Royal Olympic Countess cruise ship.
Costanza, Romania is in the background.

TDRSS On-line Information Center Available

Have questions about TDRS or the Space Network (SN)? Check out the TDRSS On-line Information Center. Discover new information about SN services using TCP/IP and TDRS use for Range Safety Support. We've also included new information about some unique TDRSS applications, including PORTCOM, ECOMM, and TILT. The Javascript search engine will help you locate the specific information you are looking for. You can also email questions to us using our feedback form. We'll direct your question to the appropriate expert and return an answer directly to you via email. The site is updated twice monthly to ensure information is current and accurate.

The TDRSS On-line Information Center can be found at *http://nmsp.gsfc.nasa.gov/tdrss/*.

Detailed information is currently available on:

- The Tracking and Data Relay Satellites (including TDRS H, I, J)
- The White Sands Complex including WDISC
- Guam Remote Ground Terminal
- McMurdo TDRSS Relay Terminal System
- TDRSS Telecommunication Services
- Customer Communication Systems and Products (including Transponders)
- TDRSS Applications
- Plus much more…

NCC 98 and Maintenance Plan Status

The NCC 98 Completion Release [a.k.a. Service Planning Segment Replacement (SPSR) 99.1] has been operational since June 21, 1999. The NCC 98 Completion Release achieves the implementation of the Flexible Scheduling capabilities. These capabilities are intended to optimize the usage of the TDRSS resources and increase the likelihood that a customer can schedule an event when necessary. The upcoming release of the User Planning System (see article page 9) is designed to utilize flexible scheduling. A basic description of the flexible parameters and guidelines for their use can be found in Appendix D of Revision 1 of the Interface Control Document Between the Network Control Center Data System and the Mission Operations Centers (MOC ICD). This document is available on-line at *http://ncc98.gsfc.nasa.gov/icd-chng/moc/ccb-part2.pdf.*

The NCC 98 maintenance effort is already well underway. As this article is published, the first maintenance release, NCCDS Release M00.1, is undergoing system testing. This first release resolves over 80 Problem Reports (PRs), reducing the number of workarounds and the amount of human intervention required by the sustaining engineering team. This release is scheduled to enter Operational Evaluation Testing (OET) in mid-November, and transition to operations in early February 2000.

The major component of the maintenance effort is the second release. This release targets problem resolutions requiring any redesign or database schema changes. The exact contents of this release are still being identified and prioritized. The contents will focus on:

- Improving system/software stability
- Improving system performance
- Eliminating errors that require labor-intensive workarounds by NCC operators
- Reducing human intervention by the sustaining engineering team

The preliminary schedule has the second maintenance release entering system test in February 2000 and transitioning into operations in June. This schedule may fluctuate based on the agreed-upon contents.

By JR Russell/CSC

For more information about NCC 98 and its completion and/or maintenance releases, please contact Roger Clason at (301) 286-7431.

GSFC's Mission Services Program Is Ready for the Year 2000

The Mission Services Program (Code 450) successfully completed all Year 2000 (Y2K) end-to-end testing. All systems are go! Business Continuity and Contingency Planning (BCCP) is underway.

Support for SN Range Safety Continues To Grow

In the last edition of *The Integrator*, growing attention focused on the GSFC Space Network (SN) Range Safety endeavor. In particular, the KSC Center Director, Roy Bridges, officially requested GSFC Networks support in the field of Space-Based Range Services. The GSFC Center Director, Al Diaz, officially responded in a positive light, "…GSFC is excited about this opportunity to develop this technology and explore the potential benefits of a space-based range with KSC and the United States Air Force to improve performance, increase throughput, and reduce the cost for range customers."

The SN Project is working very closely with the KSC Advanced Development Office and is assisting in the development and presentation of proposals to various NASA and industry representatives to gain more ground and support for a Proof-of-Concept Program. Recently, SN personnel attended a meeting with KSC personnel at NASA HQ to discuss the concept with the Aerospace Technology Office (Code R). The proposed plan to conduct Proof-of-Concept experiments for Space-Based Range Safety using potential "X-vehicles" was very well accepted.

Other space-based range safety events are also evolving. Lockheed Martin Space Mission Systems has initiated discussions with NASA GSFC to use the Space Network and other NASA instrumentation to perform some proof of concept testing. The Lockheed Martin team is proposing to

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fly two PORTCOMM transceivers on an airplane at Dryden Flight Research Center (DFRC) and conduct command tests using TDRSS and a simulated launch head in a basic experiment of the concept. This first step in exploring the concept will only explore very basic ideas using existing, nonflight qualified hardware and systems.

Over the next year, there will be more to come….stay tuned and look for an update in the next issue of *The Integrator*.

By John Smith/LMCO/GSFC Code 451

For further information, please contact Ted Sobchak/GSFC at (301) 286-7813, or via email at Ted.Sobchak@gsfc.nasa.gov.

Early Communications System Still in Demand

In past editions of *The Integrator* there have been several articles concerning the International Space Station (ISS) Early Communications (ECOMM) system. *The Integrator* has followed this story from development, through testing, into implementation, and finally operations.

Now, extended TDRSS services using ECOMM have been requested to support ISS due to lack of continuous coverage from the Russian ground stations. The TDRS Single Access (SA) services will be scheduled for extended periods for forward and return link support via ECOMM to augment the Russian ground station command and telemetry operations. The extended support provided through the ECOMM interface is primarily required for continuing characterization and conditioning of the ISS batteries, and for ongoing evaluation of the ISS systems on orbit.

In September 1999, the GSFC Networks Test organization, in particular members of the ISS Test Team, were contacted to support ECOMM antenna testing. The on-orbit ECOMM antennas have been troubled since the system was first installed during the STS-88 mission in December 1998. In preparation for possible replacement, the ISS JSC Engineering team worked diligently to verify a replacement ECOMM antenna. The GSFC Test Personnel participated in the testing of the replacement antenna.

Will there be more ECOMM activities in the future? Only time will tell, but one thing is certain: when the GSFC Mission Service Program is called on to support ECOMM, we are ready!

By John Smith/LMCO/GSFC Code 451

For further information, check out the Human Spaceflight Web site at http://ntipalpha.atsc.allied.com/hpshuttl/hsd/hsd.html, or contact Ted Sobchak at (301) 286-7813 or via email at Ted.Sobchak@gsfc.nasa.gov

White Sands Alternate Resource Terminal Will Extend the Life of TDRS F1

The implementation of the White Sands Alternate Resource Terminal (WART) is underway, with a target for completion sometime in November. WART will allow extended operation of the TDRS F1 to support National Science Foundation (NSF) South Pole science operations with wide IP connectivity. WSC personnel are implementing the Tracking, Telemetry, and Command (TT&C) portion, which is in the final stages of verification. The User Services System (USS) portion is being implemented at GSFC and will be sent to WSC in early November. WART hardware consists of some new equipment, as well as a significant portion of equipment from the defunct GRO Remote Terminal System in Australia. When completed, WART will allow TDRS F1 to continue providing valuable service to our cooperative partner, the NSF, well beyond the satellite's expected lifetime.

By Frank Stocklin/GSFC Code 451

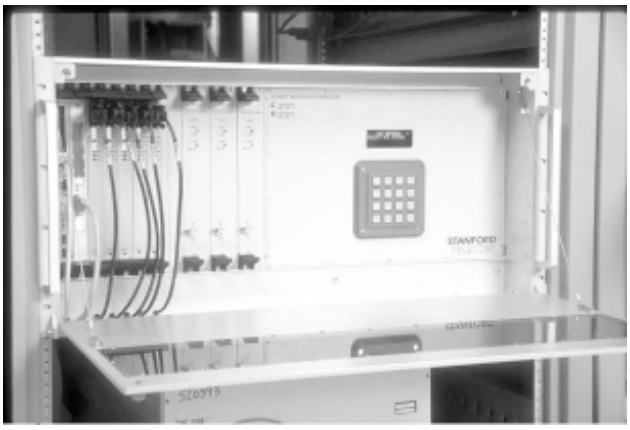
For additional information, please contact the author at (301) 286-6339 or via email at Frank.Stocklin@gsfc.nasa.gov.

Third Generation Beamforming System To Be Implemented Next Year

The Third Generation Beamforming System (TGBFS) is being implemented at the White Sands Complex and Guam. The addition of the TGBFS components will provide the basis for significantly expanding the number of Multiple Access (MA) return links at each site, while also allowing the capability for instantaneous and continuous access to those links. The Project Commitment Document (PCD) for TGBFS was approved by Space Operations Management Office (SOMO) in August 1998. A contract is in place with Stanford Telecommunications (STel) for delivery of seven Element Multiplexer Correlators (EMCs)—five operational and two spares—and one fully populated Independent Beamforming Unit Group (IBUG). All components have been assembled and are undergoing final factory testing, with delivery expected in November 1999. Acceptance testing of pre-production EMC and IBUG units was completed in August 1999. The IBUG is now considered a Commercial Off-the-Shelf (COTS) item. The TGBFS is scheduled to be operational in Guam by March 2000, at the Second TDRSS Ground Terminal (STGT) by May 2000, and at the White Sands Ground Terminal (WSGT) by June 2000.

By Tom Gitlin/GSFC Code 451

For more information on this project, please contact the author at (301) 286-9257 or via email at tom.gitlin@gsfc.nasa.gov.



The Element Multiplexer Correlator - The EMC is a single chassis installed in MA SGLTs which passively connects to the existing MA A/D quad splitter. The quad splitter provides TDRS array antenna signals to the EMC, which in turn provides the data to the IBUGs. Each EMC has the capability to feed up to 11 IBUGs.

Demand Access System Concepts Evolving

Demand Access System (DAS) studies began in 1994 to examine ways of providing better, less expensive, and less complex services to customers. The major DAS objectives are to:

- Increase the Multiple Access (MA) return customer base while minimizing costs
- Improve MA return service via extensive automation
- Reduce customer operations cost
- Drastically reduce, and preferably eliminate the need for scheduling
- Add services not currently available ("911" service, automated world-wide services across TDRSs and Space to Ground Link terminals)

Proof-of-concept demonstrations were conducted and a high-level DAS architecture developed. The current vision for DAS is dependent on TGBFS implementation (see previous article) as the TGBFS provides the framework for DAS. DAS implementation would add global system automation functions, data demodulation capabilities, and data distribution systems to the TGBFS.

The DAS Project Commitment Document has undergone extensive review and is expected to be presented to the Space Operations Management Office (SOMO) in November 1999.

By Tom Gitlin/GSFC Code 451

For more information, please contact the author at (301) 286-9257 or via email at tom.gitlin@gsfc.nasa.gov

The Individual Beamforming Unit Group - Each IBU within an IBUG represents a low-cost, one circuit card beamformer. Each IBU processes antenna data fed to it by the EMC and it provides digital and intermediate frequency outputs which can be connected to receivers. Each IBUG can contain six individual beamformers.

Space Network Web Services Interface Will Provide New Option for Customers

The Space Network (SN) Web Services Interface (SWSI) is a generic, web-based, cross-platform system that will provide customers an interface for performing Tracking and Data Relay Satellite (TDRS) scheduling and real-time service monitoring and control.

New SN customers have traditionally been provided with a limited number of options for implementing their interfaces to the Network Control Center. A full-featured SN scheduling tool is provided by the User Planning System (UPS), which runs on a Hewlett-Packard (HP) Unix host. New customers desiring to use UPS for scheduling must either purchase their own systems at a significant cost, or interface with an institutional UPS located within the Multisatellite Operations Control Center (MSOCC).

No standard option exists to provide a real-time (reconfiguration and performance data monitoring) interface. All SN customers have been required to implement their own systems at considerable cost.

The initiative of SWSI is to provide a simple low-cost interface option for suborbital and infrequent SN customers. The SWSI is designed to be accessed from NASA's Integrated Services Network (NISN) Closed or Open IP Operational Networks (IONET). NISN's Open IONET allows access from the NASA Science Internet and the public Internet. SN customers will be able to perform scheduling, real-time functions and state vector storage for only the cost of a desktop computer or workstation and a web browser.

Prototyping and proof-of-concept work was completed as a NASA in-house project, and has been used to provide support to the Long Duration Balloon Project (LDBP). The SWSI is expected to be operational in the fall of 2000.

By Tom Sardella/GSFC Code 583

For additional information, please contact the author at (301) 286-7686 or via email at Tom.Sardella@gsfc.nasa.gov

Coming Attractions

EOS Data and Information System Ready for TERRA Launch

The Earth Observing System (EOS) Data and Information System (EOSDIS) Mission Systems and Science Systems are ready to support the launch and subsequent ground operations of the TERRA spacecraft. Complications at the Vandenberg launch site, however, have led to a series of launch slips. TERRA is now scheduled for launch no earlier than December 10, 1999. All EOSDIS systems have been tested to a level which indicates launch readiness, but scenario exercises will continue to be run, and system release refinements tested and incorporated up to fueling for launch and system freeze. EOSDIS participation in development of the EOS PM-1 systems is on schedule for support of a December 2000 launch. EOSDIS will hold the PM-1 Mission Operations Review October 18-20, 1999.

By Gene Smith/GSFC Code 423/581

For more information, please contact the author via email at gene.smith@gsfc.nasa.gov.

Microwave Anisotropy Probe Constructed at GSFC

The Microwave Anisotropy Probe (MAP) is scheduled to launch on November 7, 2000 on a Delta II rocket out of the Eastern Range. MAP will orbit the Sun-Earth Lagrange point, L2, 1.5 million km beyond the earth. MAP will utilize a lunar gravity assist to get to L2. The MAP instrument is a differential radiometer designed to detect temperature fluctuations in the cosmic microwave background. The cosmic microwave background is the remnant afterglow of the Big Bang, and the tiny temperature differences from place to place on the sky provide a wealth of information about the basic nature of our universe.

MAP is a GSFC in-house project and is currently under construction in Building 29, room 150 in the Medium Class Explorer (MIDEX) Integration, Test, and Operations Center (MITOC). The project is planning to integrate the spacecraft with the instrument in the near future. Once the instrument

is integrated, the project will enter the Observatory level test phase.

The MAP Science and Mission Operations Center (SMOC) is located at GSFC in Building 3, room S25. From the SMOC the Spacecraft Controller Team will perform all mission operations. The Jet Propulsion Laboratory's (JPL's) Deep Space Network (DSN) will track MAP with its 70 m antennas in Goldstone, Madrid, and Canberra.

By Steve Coyle/GSFC Code 581

For more information, visit the MAP web site at: http://map.gsfc.nasa.gov.

"Cosmic Weedwacker" Readies for Launch

The Imager for Magnetopause-to-Aurora Global Exploration (IMAGE) mission is a polar-orbiting spacecraft scheduled for launch on February 15, 2000, from the Vandenburg Air Force Base on a Delta II Launch Vehicle. The sophisticated instruments to be flown on IMAGE will provide the first global images of the Earth's inner magnetosphere. The images will help space scientists understand how energy, mass, and momentum are transferred from the solar wind (the flow of charged particles from the Sun) to the magnetosphere.

IMAGE is the first of the Medium Class Explorer (MIDEX) missions. The MIDEX missions are under the control of GSFC Explorers Project, Code 410. IMAGE is a Principal Investigator (PI) mode mission, which means that the PI's institution has Project Management authority for the mission. The PI for IMAGE is Jim Burch from the Southwest Research Institute (SwRI) of San Antonio, TX. Lockheed Martin Missiles and Space Corporation (LMMS) of Sunnyvale, CA is in charge of the spacecraft bus development. GSFC is in charge of IMAGE command and control, health and safety, telemetry data processing, browse product distribution, science data processing and distribution, payload and observatory integration and test, Electrical Ground Support Equipment (EGSE), and payload and observatory test console operations. The Jet Propulsion Laboratory's (JPL's) Deep Space Network (DSN) will provide all Space-to-Ground interfaces to the IMAGE Observatory.

IMAGE Science Instruments include the Low Energy Neutral Atom imager (LENA) from GSFC, the Medium Energy Neutral Atom imager (MENA) from SwRI, the High Energy Neutral Atom imager (HENA) from the Applied Physics Lab (APL), the Extreme Ultra Violet imager (EUV) from the University of Arizona, the Far Ultra Violet imager (FUV) from the University of California-Berkeley, and the Radio Plasma Imager (RPI) from the University of Massachusetts-Lowell.

IMAGE is a spin stabilized spacecraft (0.5 RPM) with a 13.5 hour highly elliptical polar orbit (1,000km x 44,000km). It has four radial sounding antennae that extend out 250m in the x, y, -x, and -y spacecraft coordinates, giving IMAGE its nickname—the "cosmic weedwacker." To reduce scheduling impacts on the DSN, IMAGE is employing the highest S-Band data rate the DSN has ever accommodated—2.2875 Mbps.

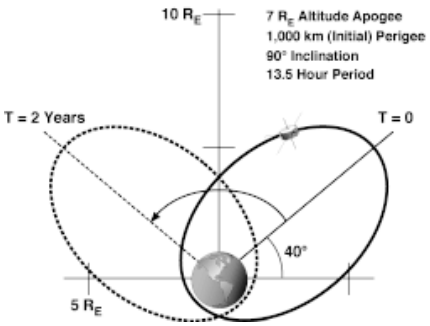


IMAGE Orbit Diagram

(continued on page 30)

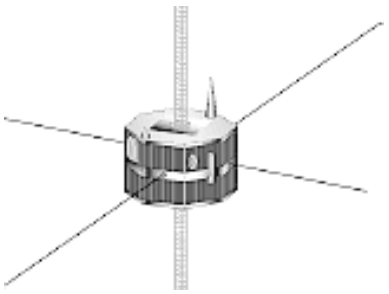


IMAGE Spacecraft

Facts in Brief
Launch Date: 15 February 2000
Launch Vehicle: Delta
Launch Site: Point Arguello (Vandenberg AFB)
Orbit: 1000 km x 7 RE altitude polar orbit
Mission Duration: Two years
Telemetry: 44 kbps via DSN

(continued from page 29)

IMAGE will also be operating in a "Lights-Out" mode to reduce the lifetime operations costs for the mission.

The IMAGE Science Instruments were delivered to SwRI in January 1999, and completed payload testing in March 1999. Payload to spacecraft integration was completed in June 1999. Observatory (payload and spacecraft) environmental testing was completed at LMMS in July 1999. RF compatibility testing has been performed using the DSN's Compatibility Test Trailer (CTT), and will conclude with a final test at the launch site. Three IMAGE mission simulations have been performed using the IMAGE observatory and the CTT, with two more mission simulations scheduled; the last of which will be performed at the launch site. Mission Readiness Tests (MRTs) between the DSN sites located in Madrid, Spain; Goldstone, CA; and Canberra, Australia began in October 1999.

By Wayne Gustafson/GSFC Code 568/IMAGE Mission Operations Manager

For more information on this mission, please visit http://image.gsfc.nasa.gov/ on the World Wide Web, or contact the author via email at wgustafs@pop700.gsfc.nasa.gov.

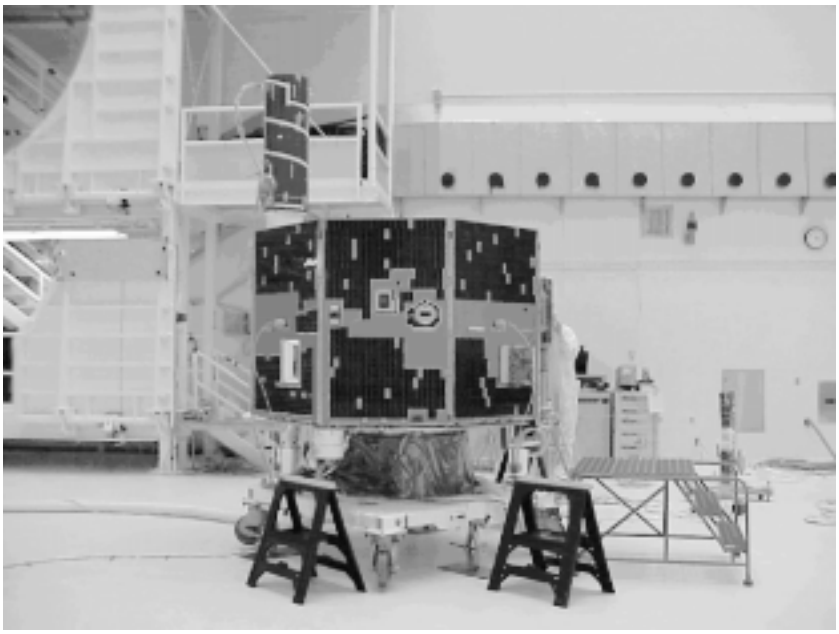


IMAGE Functional Test in LMMS' Highbay Facility

NASA and Boeing Developing X-37 Technology Demonstrator

NASA and the Boeing Company, in a $173 million cooperative agreement, are developing a new experimental space plane dubbed the X-37. The X-37 is an unmanned reusable vehicle to be carried into orbit by the Space Shuttle. It will also be capable of launch from expendable launch vehicles. The X-37 will demonstrate 41 airframe, propulsion, and operations technologies during the four-year program.

The X-37 is a small plane with a wingspan of 15 feet and a length of 27.5 feet. The experiment bay is seven feet long and four feet in diameter, and will support a 500-pound payload. The vehicle will have propulsion capabilities for maneuvering in space and for powered return flight from orbit. The first test flights are scheduled for 2002.

Susan Turner, from NASA's Marshall Space Flight Center in Huntsville, AL, was named the project manager of the X-37 technology demonstrator, and will oversee the Government and industry team developing the vehicle.

X-37 program personnel have initiated conversations with the Space Network (SN) project office regarding use of the Tracking and Data Relay Satellite System for on-orbit and re-entry coverage of the X-37. The SN project has participated in a number of discussions with Boeing about link margins, operations scenarios, the effects of plasma, and other topics. Plans are currently underway to conduct the first X-37 Technical Interchange Meeting at GSFC in the near future.

Artist's Rendering of the X-37 Space Plane

By Joe St.John/LMSC

For additional information, check out the Human Spaceflight web site at http://ntipalpha.atsc.allied.com/hpshutt/hsd/hsd.html, or contact Ted Sobchak at (301) 286-7813 or via email at Ted.Sobchak@gsfc.nasa.gov

X-38: Last Drop Test for 1999

Engineers at NASA's Dryden Flight Research Center (DFRC) and the Johnson Space Center (JSC) are preparing for the next atmospheric drop test of vehicle 132 (or ship 2) on December 2, 1999. This drop test is the last flight set scheduled for 1999. The X-38 is a technology demonstration vehicle and is the predecessor for an ISS Crew Return Vehicle (CRV).

The prior two flight tests focused on a new flight control system and drogue chute. The new flight control system is expected to respond more quickly to aerodynamic changes. New mechanisms in the drogue chute were added to create a more stable transition to the parafoil, which is a steerable parachute that is used for landing.

Atmospheric drop tests of the X-38 will continue at Dryden for the next three years using increasingly complex test vehicles. The free flights will increase in altitude to a height of 45,000 feet and include longer flight times for the test craft before deployment of the parafoil.

By Danh Nguyen/LMCO

For additional information, check out the Human Spaceflight web site at http://ntipalpha.atsc.allied.com/hpshutt/hsd/hsd.html, or contact Ted Sobchak at (301) 286-7813 or via email at Ted.Sobchak@gsfc.nasa.gov

X-38 Vehicle 132 flies during the July 9, 1999 research flight.

NASA Photo by Carla Thomas.

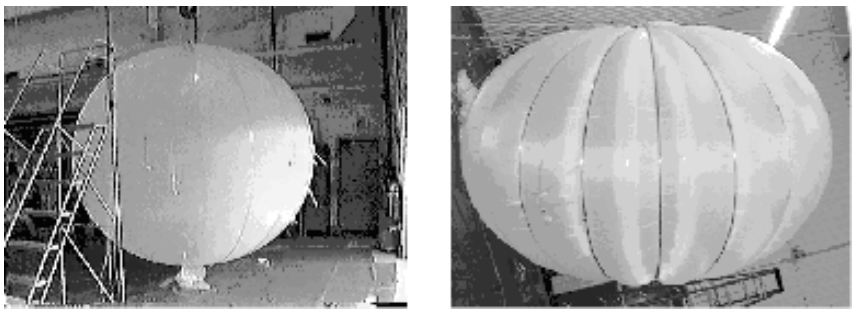
The Ultra Long Duration Balloon Project Status Update

The Ultra Long Duration Balloon (ULDB) Project is managed by GSFC's Code 820/Balloon Program Office. The objective of the project is to develop balloon systems capable of supporting scientific observations above 99% of the Earth's atmosphere for durations approaching 100 days. The ULDB's TIGER demonstration flight is scheduled for December 2001. The design goal is to support a scientific payload of 2200 pounds and to be able to deliver 800 watts of continuous power to the scientific instrument, based on a 12-hour day and night. The scientist will be able to command his instrument and receive science data at his home institution via the Internet. The telemetry design goal may utilize a commercial global satellite network as well as TDRSS, enabling a 50 kbps average downlink and a downlink greater than 50 kbps in the line of sight. The average line-of-sight uplink will be 100 bps.

The ULDB Project continues to work with the Space Network Project to coordinate and integrate required services for the test flight of the balloon in April 2000.

By Danh Nguyen / LMCO

For additional information, check out the web site at http://www.wff.nasa.gov/~uldb/index.html, or contact Ted Sobchak at (301) 286-7813 or via email at Ted.Sobchak@gsfc.nasa.gov



ULDB Designs - Spherical (left) and Pumpkin (right)

Milestone Chart Update

A new milestone schedule is in the works! It will reflect activities and schedules for the newly formed Mission Services Program. We will provide a copy of this new chart, along with an updated Ground Network Project Milestone chart, in the next issue of *The Integrator*.

Edited by: Lena Braatz (Booz·Allen & Hamilton)
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The Integrator can be found on line at *http://nmsp.gsfc.nasa.gov/integrator/*

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